TR-137

TECHNICAL REPORT

A MARINE MAGNETIC SURVEY SOUTH OF THE HAWAIIAN ISLANDS

Geomagnetics Branch
Marine Surveys Division

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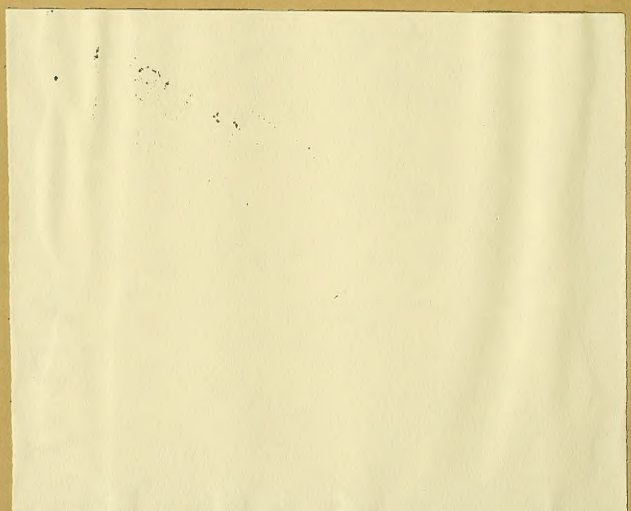
ABSTRACT

A detailed shipboard magnetic survey of a 56,000 square mile area south of the Hawaiian Islands has revealed large magnetic lineations. The largest of these lineations extends for more than 270 miles across the entire survey area. These magnetic features suggest the presence of major geologic faults in this region.



FOREWORD

This report presents geomagnetic data obtained during a recent geophysical and oceanographic survey in the Pacific Ocean. Systematic geophysical investigations of the type described here are essential for developing an accurate and complete understanding of the geologic and crustal environment underlying the ocean basins.

E. C. STEPHAN
Rear Admiral, U. S. Navy
Commander

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FIGURES

I. INTRODUCTION

In June and July 1961, a continuous profile, marine magnetic survey was conducted south of the Hawaiian Islands, between latitudes 17°45' and 21°15' North, longitudes 158° 15' and 163°15' West. (See Index Chart, Figure 1.) This survey was conducted by the USS REHOBOTH (AGS-50) as part of the U. S. Naval Oceanographic Office* Project O-162, Equatorial Pacific Survey. The general purpose of the survey was to collect data relevant to the physical, chemical, and biological aspects of the ocean environment in this area.

This report is concerned primarily with the geomagnetics phase of the survey. Bathymetric data are included to illustrate certain points of correlation and interpretation. The analyses and interpretation of data presented here are limited to the identification and description of major features. This has been done in order to make the survey results available to other interested investigators at the earliest date.

*In accordance with Public Law 87-533 effective 10 July 1962, the U. S. Navy Hydrographic Office was redesignated as the U. S. Naval Oceanographic Office.

II. SURVEY OPERATIONS

A. Conduct of Survey

The main survey was conducted in a rectangular area covering 56,000 square miles. Survey lines were run in an east-west direction at a spacing of five to seven miles, progressing from south to north. (See Track Chart, Figure 2.) Eight development surveys were conducted in locations where seamounts occur. (See Index Chart, Figure 1.) The development-area survey lines, in general, were from five to fifteen miles long and were run in both north-south and east-west directions. The average ship's speed when surveying was 12 knots. Bathymetric and magnetic data were collected simultaneously along all survey lines.

Throughout the survey area, the ship's position was fixed by Loran-A. The fix interval was normally 30 minutes (10 minutes on development surveys). Fix accuracies ranged from $\pm\frac{1}{2}$ mile to ± 2 miles. The most accurate fixes were in the south-central part of the area and the least accurate in the southwestern part.

B. Instrumentation

Magnetic total intensity measurements were made with a Varian nuclear resonance magnetometer, model V-4931, modified for use as a marine survey instrument. The sensor unit was towed approximately 500 feet astern of the ship to reduce the effect of the ship's magnetic field. Because of equipment design, magnetic data were recorded as "magnetometer counts", a unit of measurement

inversely related to the magnetic field intensity. These units were recorded in analog form on a strip-chart recorder and in digital form on a digital printer. The sensitivity of the measurements was approximately ± 1 gamma (1 gamma = 0.00001 oersted).

Bathymetric data were obtained with a Precision Depth Recorder (Mk V) and an AN/UQN 1-D Sonar Sound Set.

III. DATA PROCESSING

The magnetic data were converted from magnetometer counts to absolute values of total magnetic intensity in gammas. These values were then plotted on a 1:500,000 scale survey track chart. A magnetic total intensity contour chart was constructed from this plot using a contour interval of 50 gammas (Figure 3). A bathymetric contour chart (Figure 4) was also constructed on a 1:500,000 scale using a contour interval of 100 fathoms. Total magnetic intensity and bathymetric charts were prepared in a similar manner for each of the development areas. Because the development-area magnetic charts were prepared independently of the large area chart, there are some differences in the contouring.

No corrections to the magnetic data were made for temporal variations of the magnetic field. Honolulu Magnetic Observatory records show that the daily fluctuation rarely exceeded 25 gammas during the survey period. No major magnetic disturbances were noted.

To more clearly identify the trends and character of the magnetic anomalies, a Residual Magnetic Intensity Contour Chart was constructed (Figure 5). This residual chart was prepared by subtracting the regional magnetic intensity values from the observed total intensity values.

Regional intensity values were computed by averaging the 9 observed values of total intensity at the center, corners, and mid-points of the sides of a 60-mile square. This average value was then plotted at the center of the 60-mile square. Regional intensity values were computed in this manner at 10-mile intervals on a north-south, east-west grid. These values were then contoured and graphically smoothed to produce the Computed Regional Magnetic Intensity Contour Chart (Figure 6).

Because bathymetric and magnetic data were collected simultaneously, the bathymetric charts and magnetic charts may be used for direct comparison of the data. No sound-velocity or other corrections have been applied to the bathymetric data.

IV. SURVEY RESULTS AND ANALYSES

As a result of this survey, the geomagnetic field and the bathymetry of a 56,000 square mile area of the Pacific Ocean have been charted in detail. The magnetic total intensity contours are shown in Figure 3, and the bathymetric contours in Figure 4.

The most significant of the magnetic features present is the northeast-southwest trending anomaly extending approximately 270 miles across the entire area. This feature trends along a very straight line having a strike of approximately North 75° East. It varies in width from approximately 15 to 45 miles, and it becomes more complex in its northeastern extremities.

Profiles A-A' through F-F' (Figures 7-12) were constructed perpendicular to this northeast-southwest feature. (See Figures 3 and 4 for profile locations.) These profiles, as well as the contour charts, show that a bathymetric feature of small relief parallels the magnetic anomaly. This bathymetric feature becomes more pronounced to the southwest, where there is a maximum relief of approximately 1200 feet.

Using empirical slope techniques, estimates of the depth to the top of the magnetic source were made on each of the constructed magnetic profiles. These calculations, as shown in Figure 13, indicate a deepening of the magnetic source to the northeast.

Other magnetic lineations present in the area may be seen most clearly on the Residual Magnetic Intensity Contour Chart, Figure 5. (The negative residuals on this chart have been shaded to aid in illustrating the trends.) In the northwest corner of the survey area, a lineation occurs with a strike parallel to that of the major magnetic lineation. South of the major feature, the lineated patterns are not as pronounced and occur at angles of 35°-45° to the main feature. Nearly all of the large seamounts in the area are located along these southern lineations. Strongly negative magnetic anomalies occur over these seamounts--more negative than should be expected at this geomagnetic inclination of 33° north.

The track charts, magnetic contour charts, and bathymetric contour charts of the eight development survey areas are presented in Figures 14 through 37. Preliminary analysis of magnetic data over the seamounts was performed utilizing a computer program originated by Victor Vacquier of the Scripps Institution of Oceanography. With this program, estimates of the intensity and direction of magnetic polarization of the seamounts in development areas 1, 2, and 4 were determined. These computations have shown that the three seamounts analyzed are reversely magnetized. Analysis of the other development areas is planned.

Examination of the magnetic and bathymetric data from this survey suggests that a major geologic fault occurs along the main magnetic lineation. The magnetic patterns north of this

lineation appear to differ from those south of the lineation. This suggests further that the fault separates areas of different geologic character. The fault appears to be a strike-slip fault. However, the direction and amount of movement along this fault are difficult to determine.

From the contour charts, it appears probable that the major magnetic feature extends beyond the limits of the survey area. If projected to the northeast, this lineation would pass through the Kalohi and Pailolo channels south of the island of Molokai. The feature is most pronounced to the west and may extend for some distance in that direction.

V. SUMMARY OF FINDINGS

This detailed survey south of the Hawaiian Islands has revealed extensive lineated magnetic anomalies. One of these anomalies strikes approximately North 75° East and extends for more than 270 miles across the entire survey area. North of this anomaly, the magnetic lineations are parallel to it. South of this line however, the lineated features strike at angles of approximately 35°-45° to the major lineation. All of the large seamounts in the survey area occur south of this magnetic anomaly. Therefore, this anomaly may lie along a major fault zone separating areas of different geologic character. Estimates of the depth to the magnetic source of this anomaly indicate the source becomes deeper to the northeast.

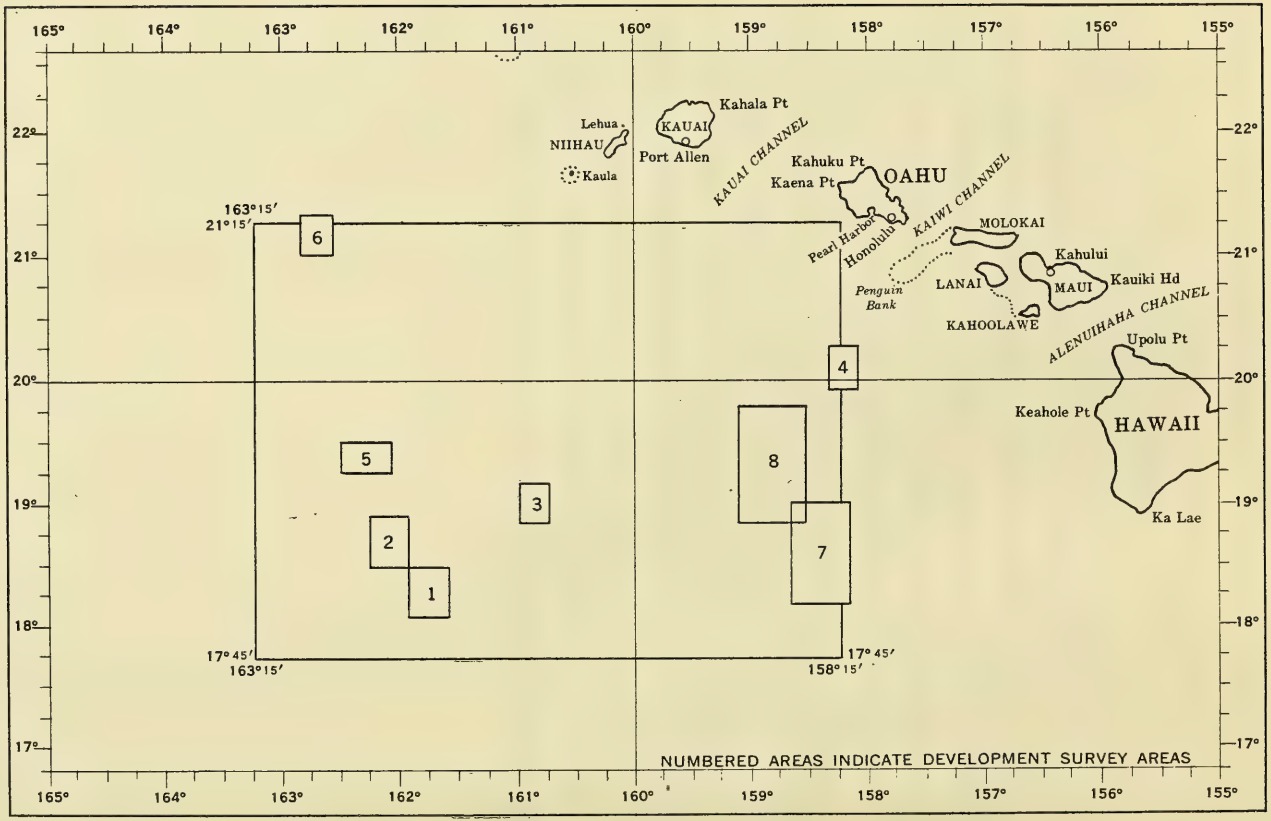

FIGURE 1 INDEX CHART

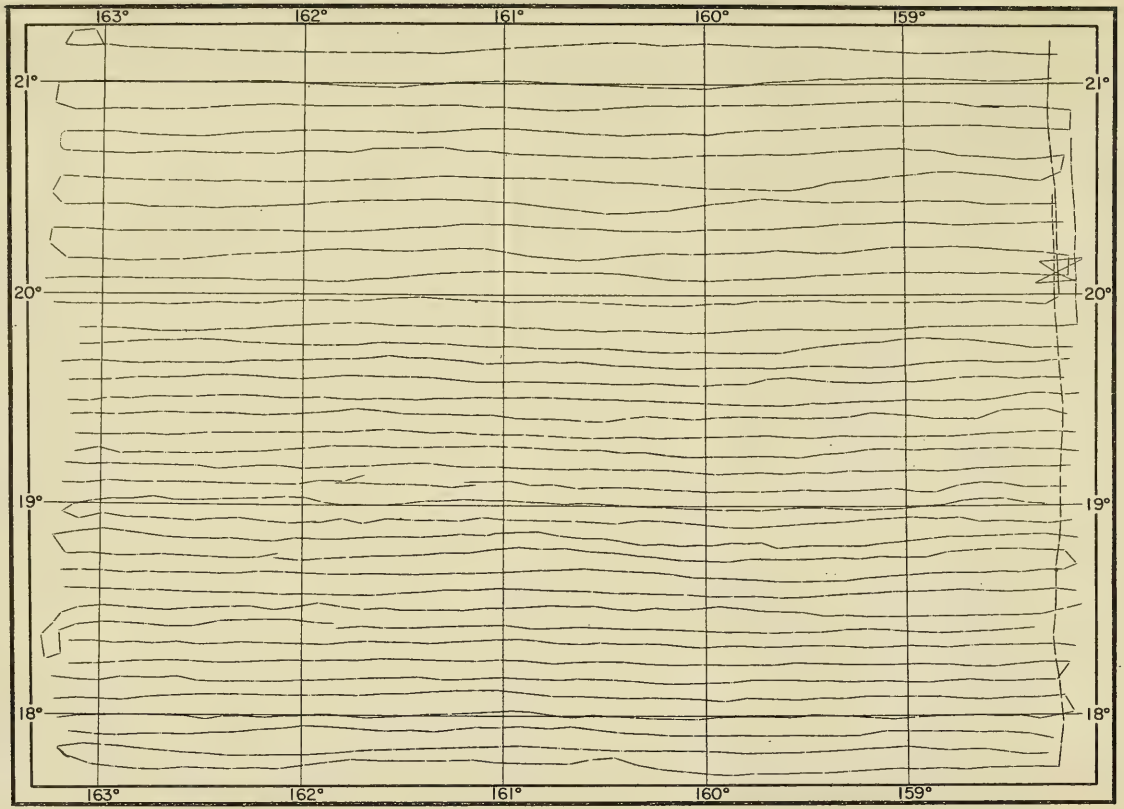

FIGURE 2 TRACK CHART

EQUATORIAL PACIFIC OCEAN

PROJECT O-162

MARINE MAGNETIC SURVEY

1961

MAGNETIC TOTAL INTENSITY CONTOUR CHART

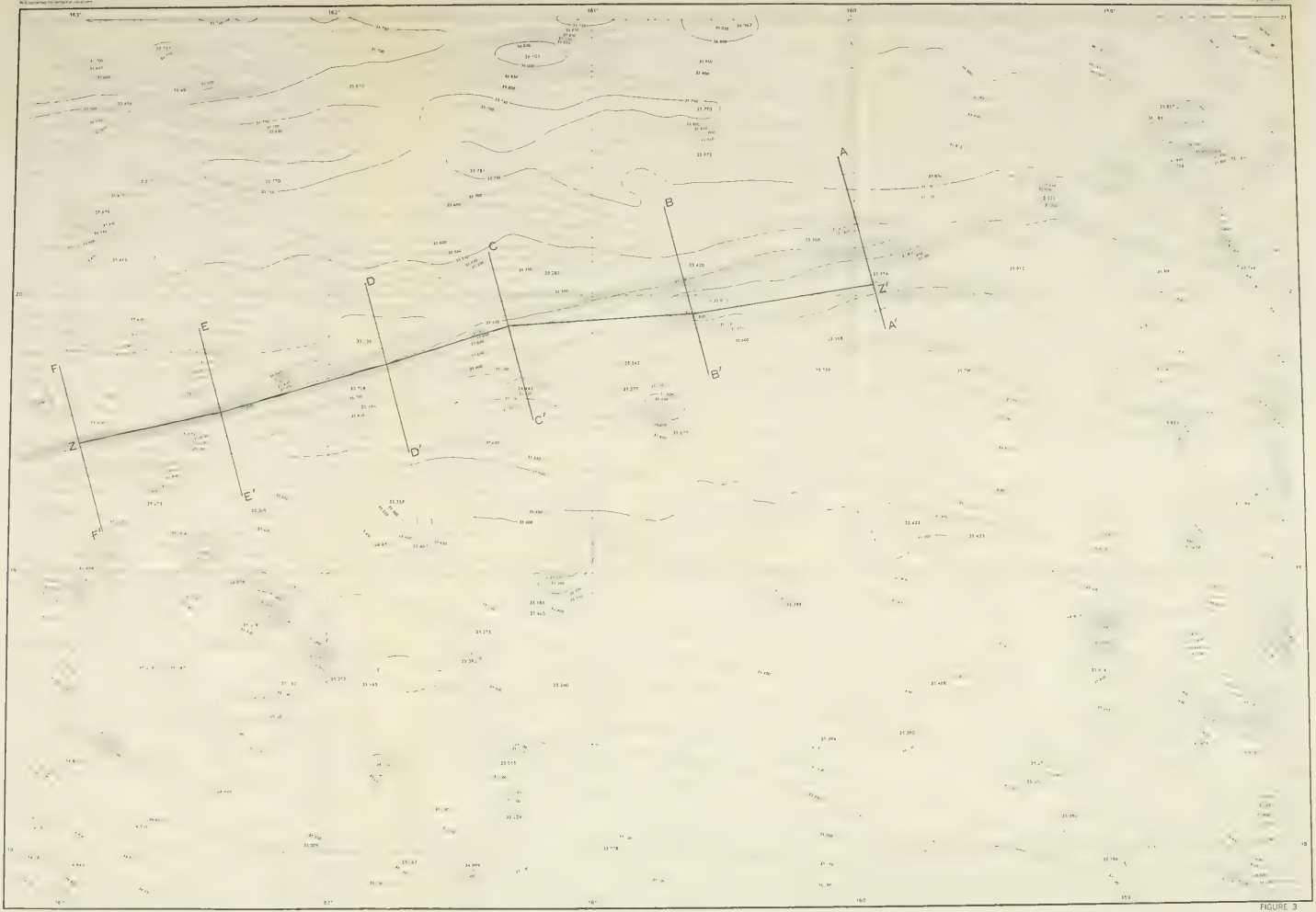

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FIGURE 3

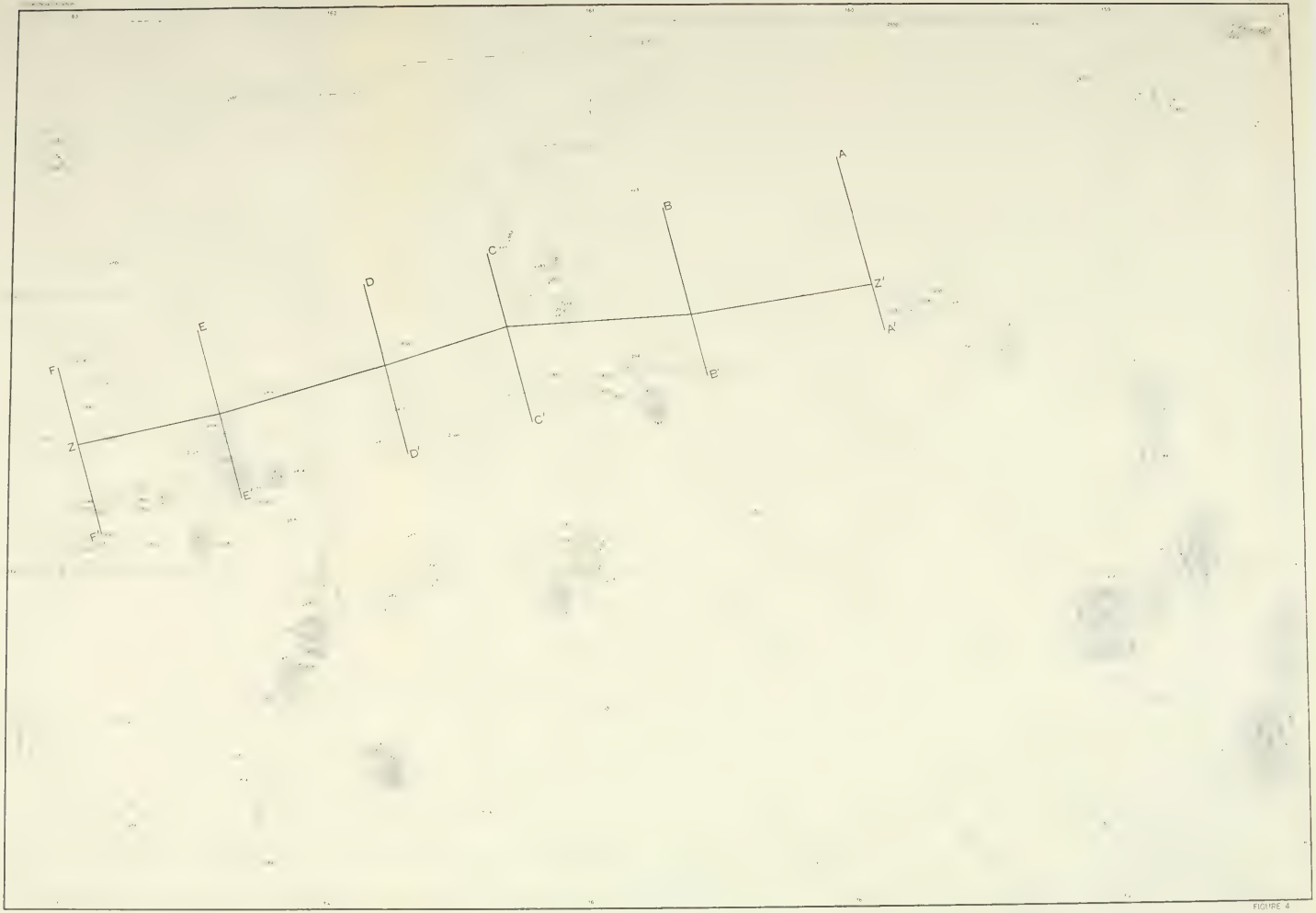
EQUATORIAL PACIFIC OCEAN

PROJECT O-162

1961

BATHYMETRIC CONTOUR CHART

Transverse Mercator Projection



U.S. NAVY HYDROGRAPHIC OFFICE

FIGURE 4

EQUATORIAL PACIFIC OCEAN

PROJECT O-162

MARINE MAGNETIC SURVEY

1951

RESIDUAL MAGNETIC INTENSITY CONTOUR CHART

(MAGNETIC REGIONAL GRADIENT REMOVED)

U. S. NAVY HYDROGRAPHIC OFFICE

FIGURE 5

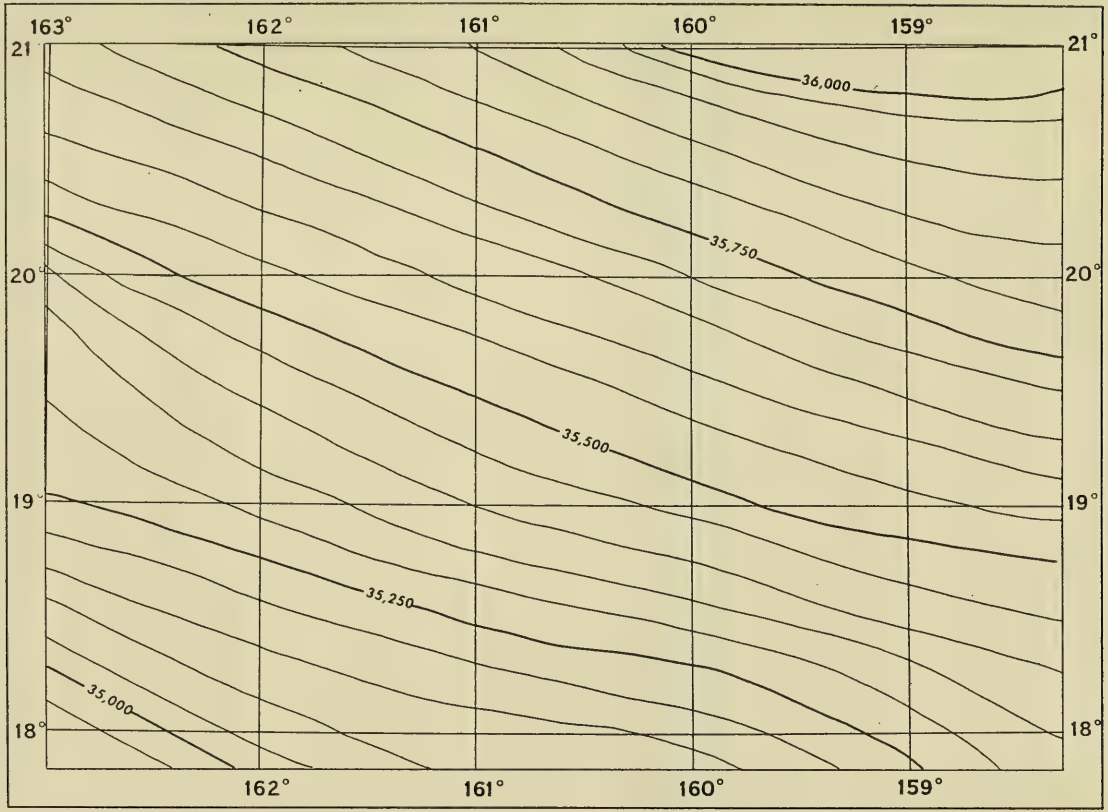


FIGURE 6 COMPUTED REGIONAL MAGNETIC INTENSITY CONTOUR CHART

UTM Projection Contour Interval 50 Gammas

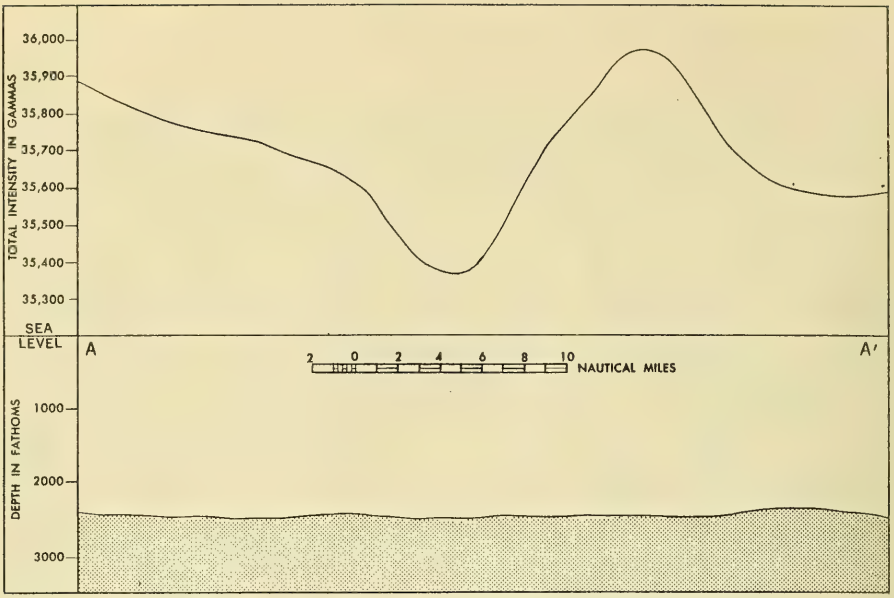


FIGURE 7 MAGNETIC AND BATHYMETRIC PROFILES A—A'

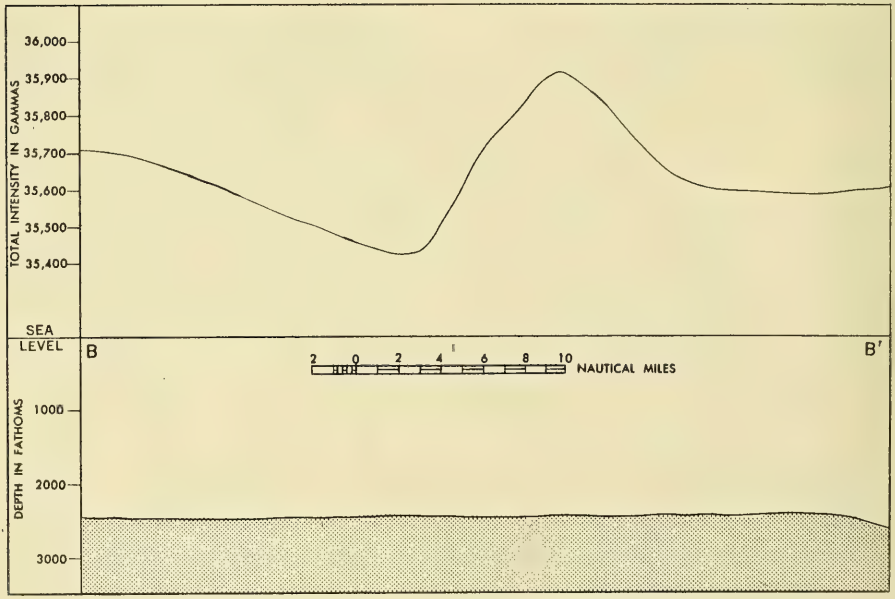


FIGURE 8 MAGNETIC AND BATHYMETRIC PROFILES B—B'

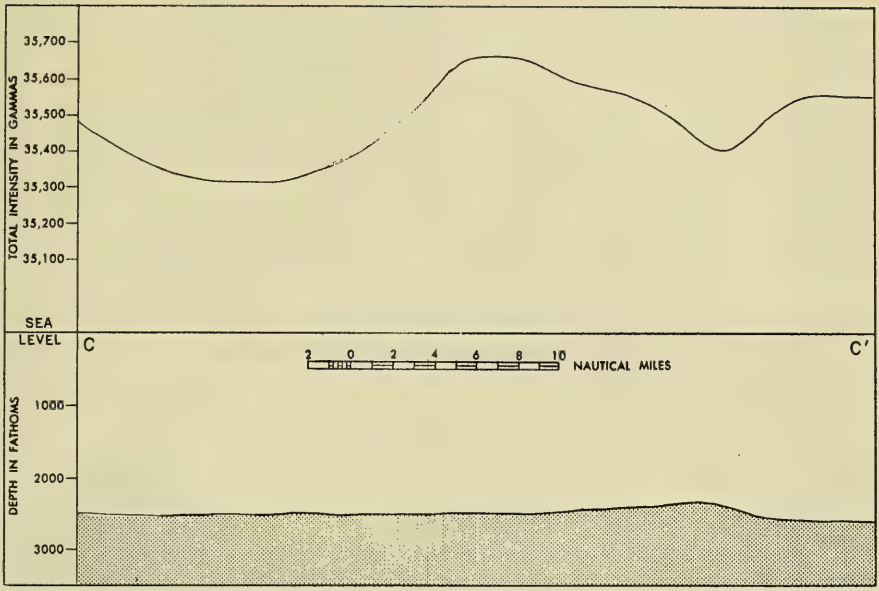


FIGURE 9 MAGNETIC AND BATHYMETRIC PROFILES C–C'

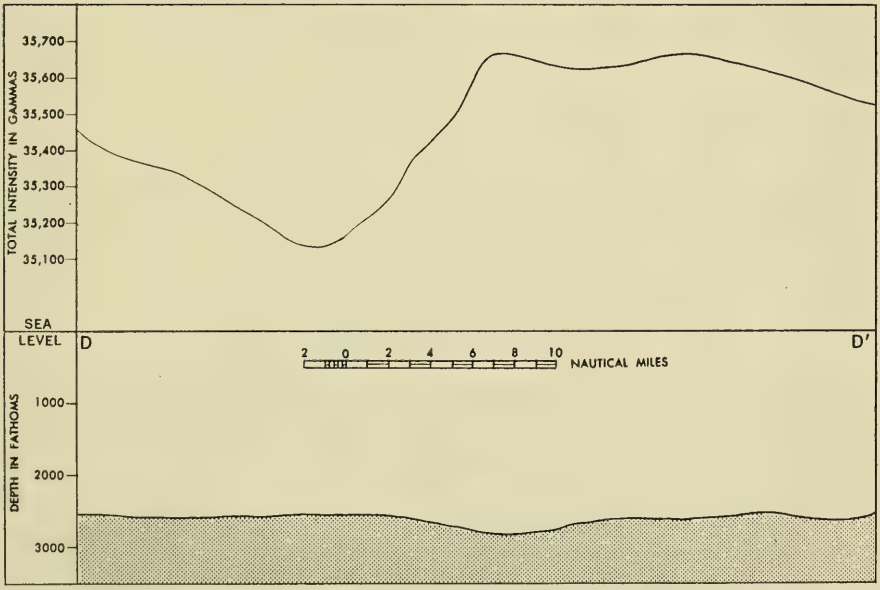


FIGURE 10 MAGNETIC AND BATHYMETRIC PROFILES D–D'

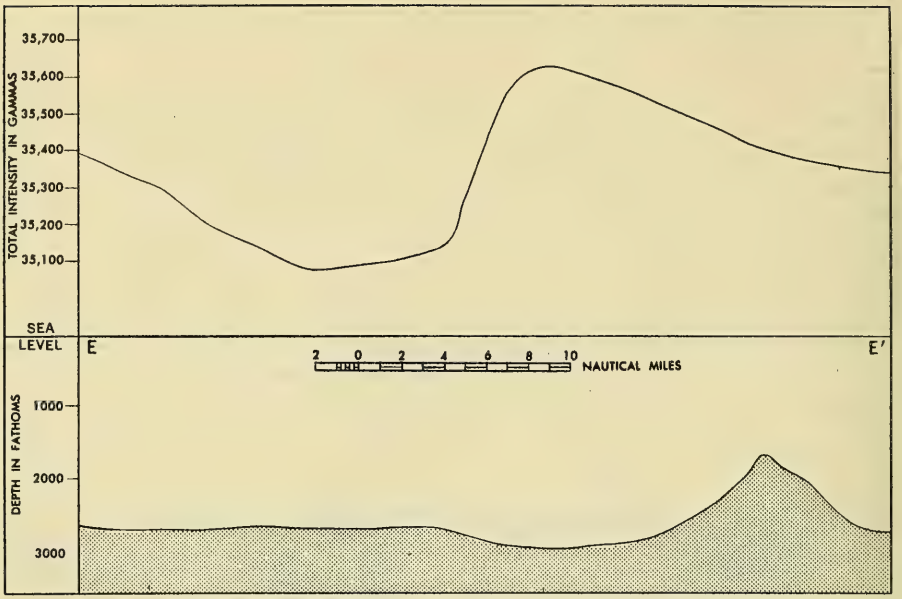


FIGURE 11 MAGNETIC AND BATHYMETRIC PROFILES E—E'

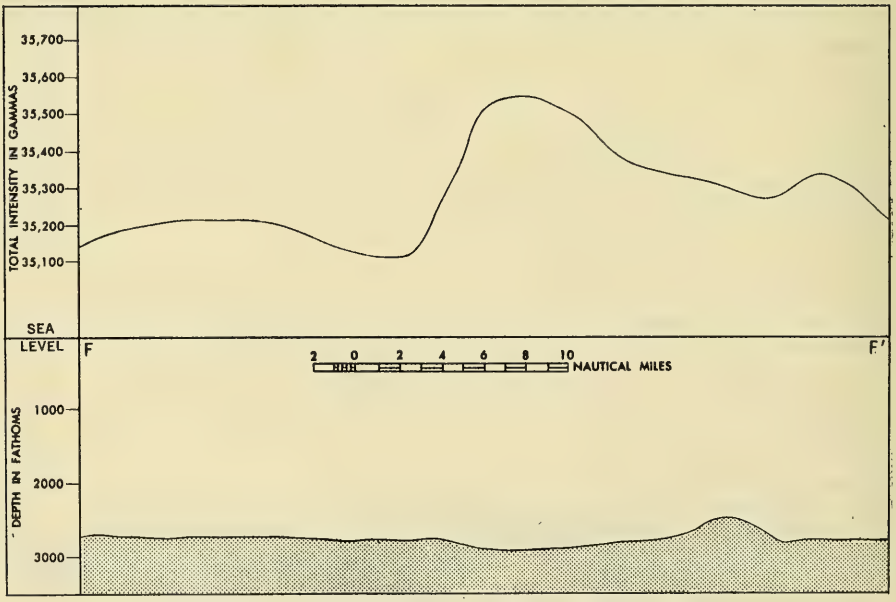


FIGURE 12 MAGNETIC AND BATHYMETRIC PROFILES F—F'

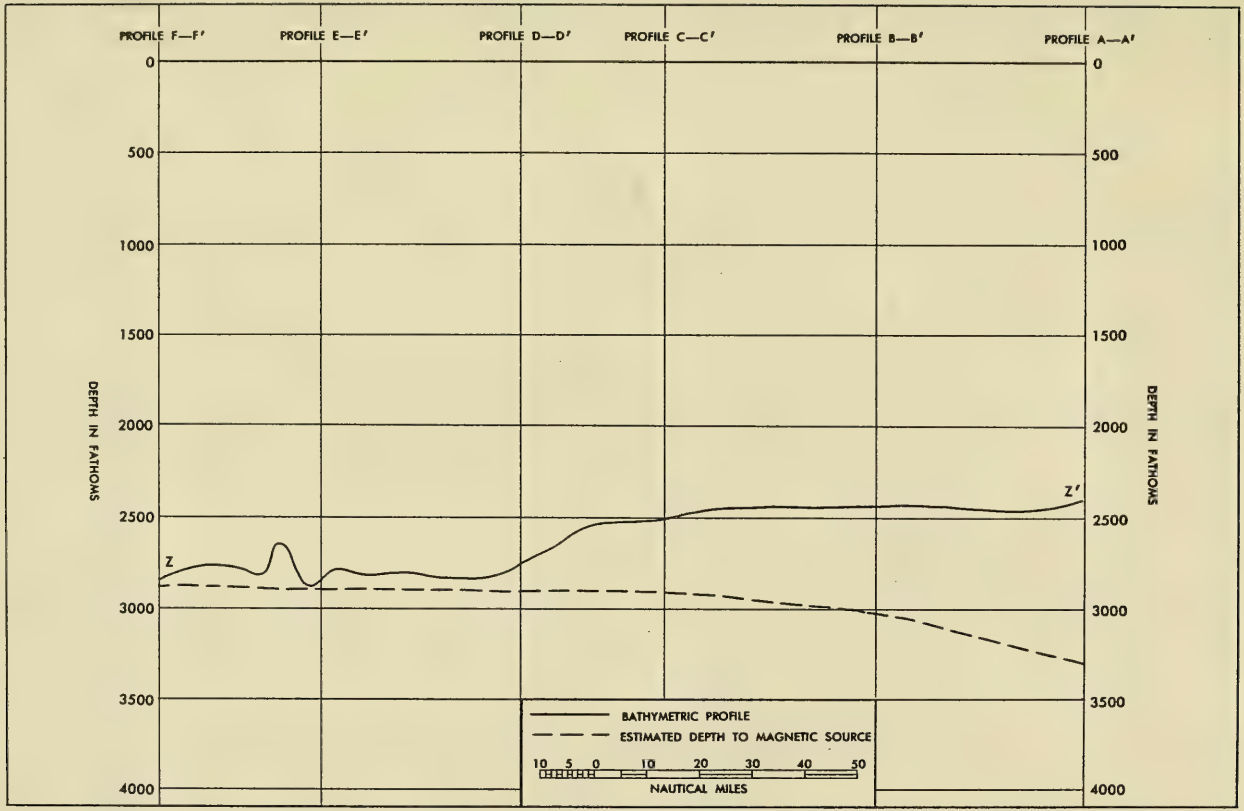


FIGURE 13 COMPARISON OF BATHYMETRIC PROFILE Z-Z′ AND PROFILE OF ESTIMATED DEPTH TO MAGNETIC SOURCE

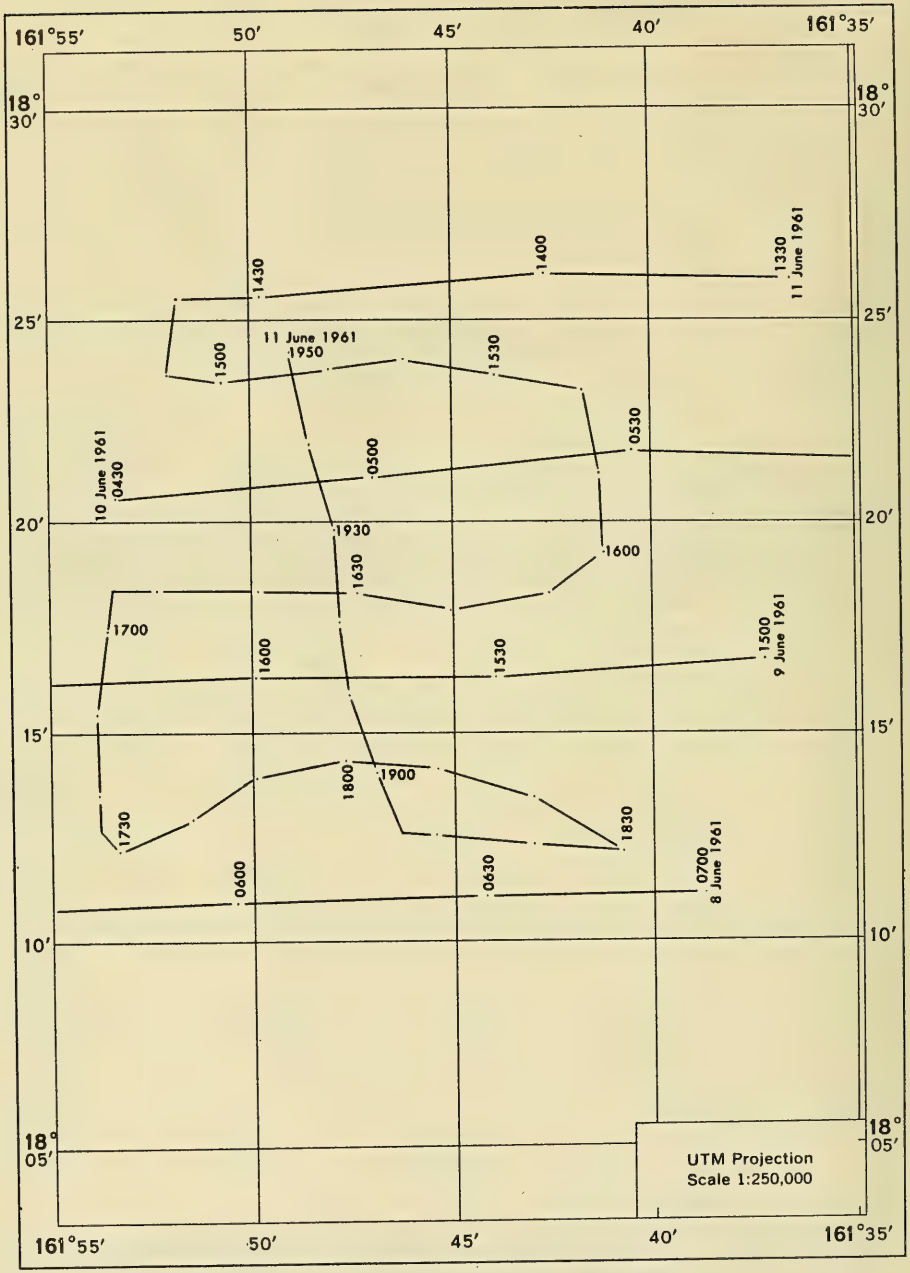


FIGURE 14 DEVELOPMENT AREA 1 TRACK CHART

FIGURE 15 DEVELOPMENT AREA 1 MAGNETIC TOTAL INTENSITY CONTOUR CHART

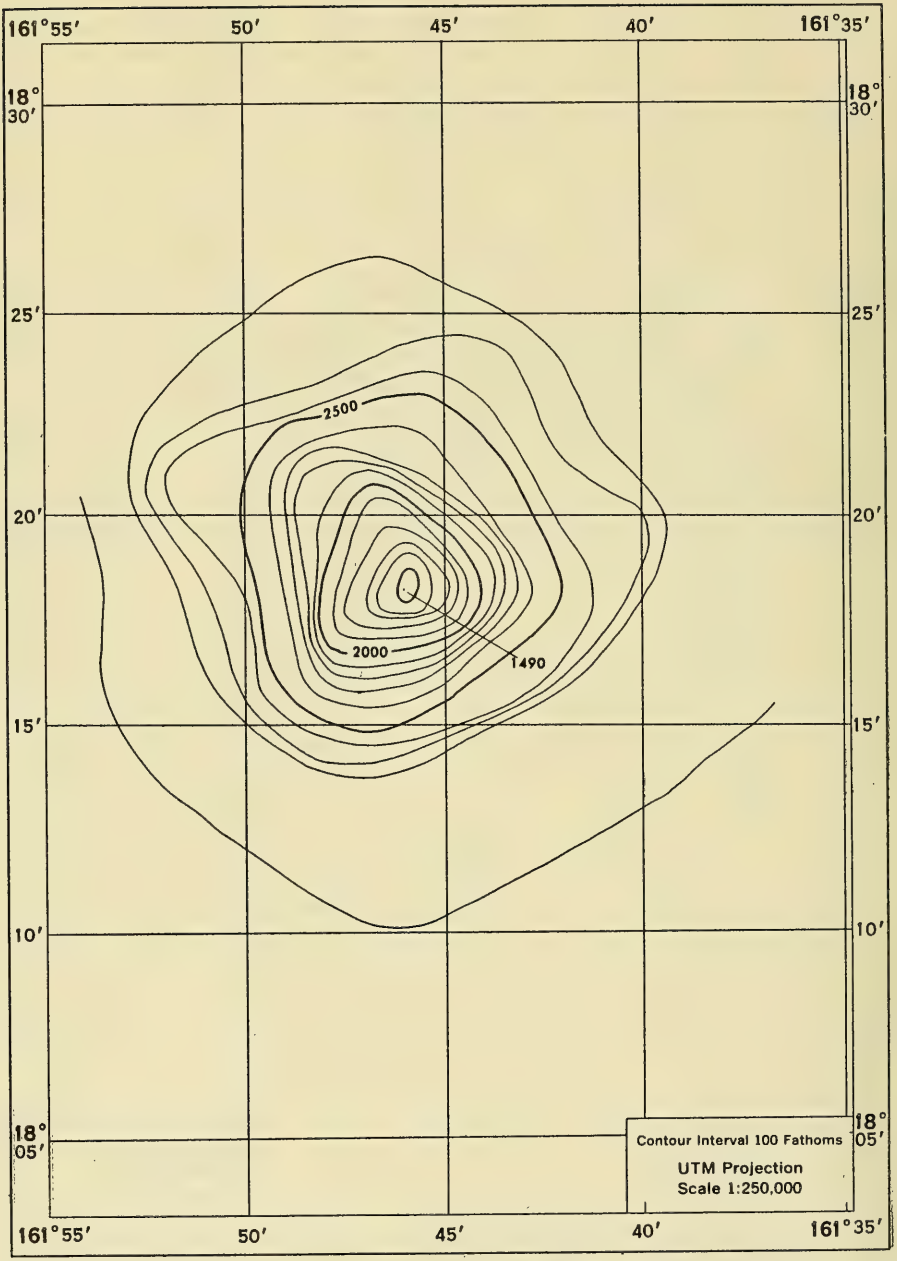


FIGURE 16 DEVELOPMENT AREA 1 BATHYMETRIC CONTOUR CHART

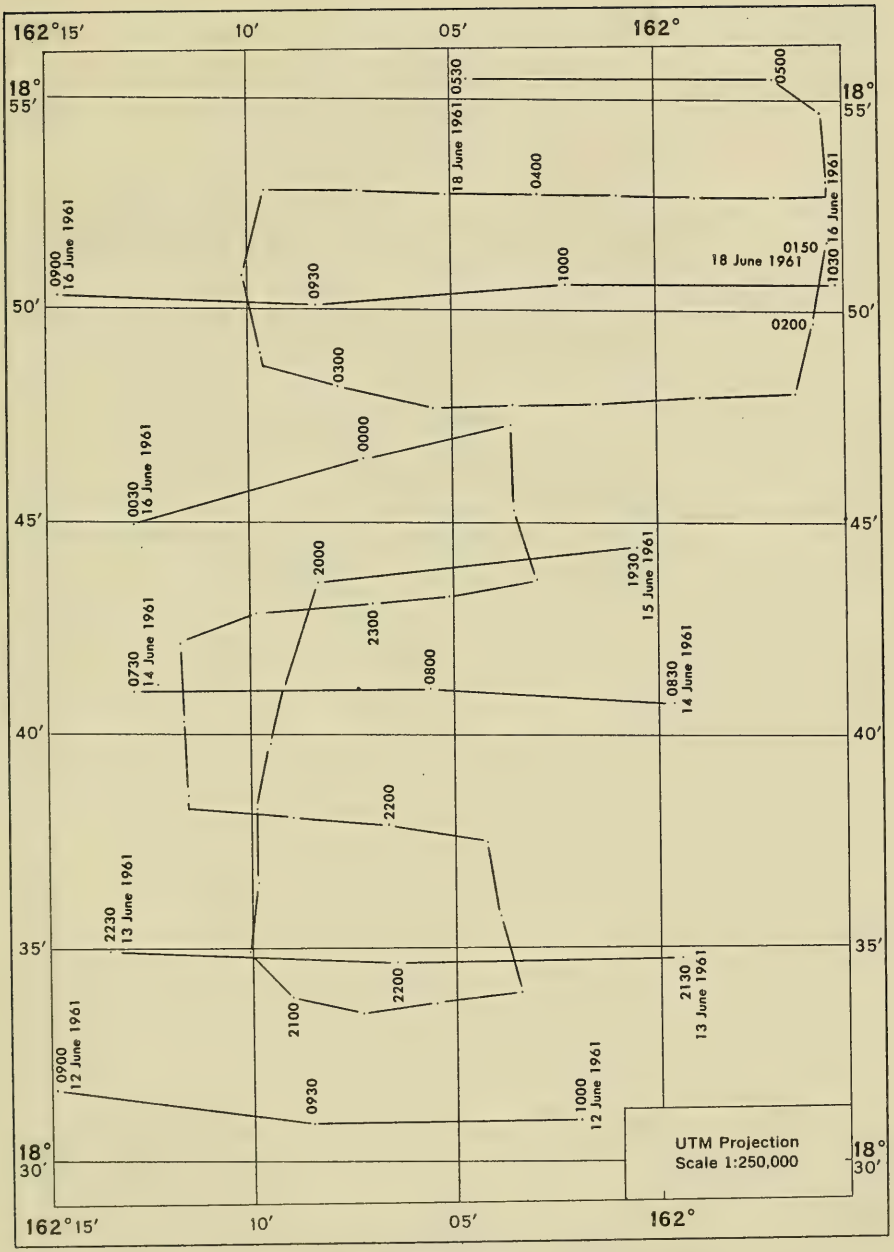


FIGURE 17 DEVELOPMENT AREA 2 TRACK CHART

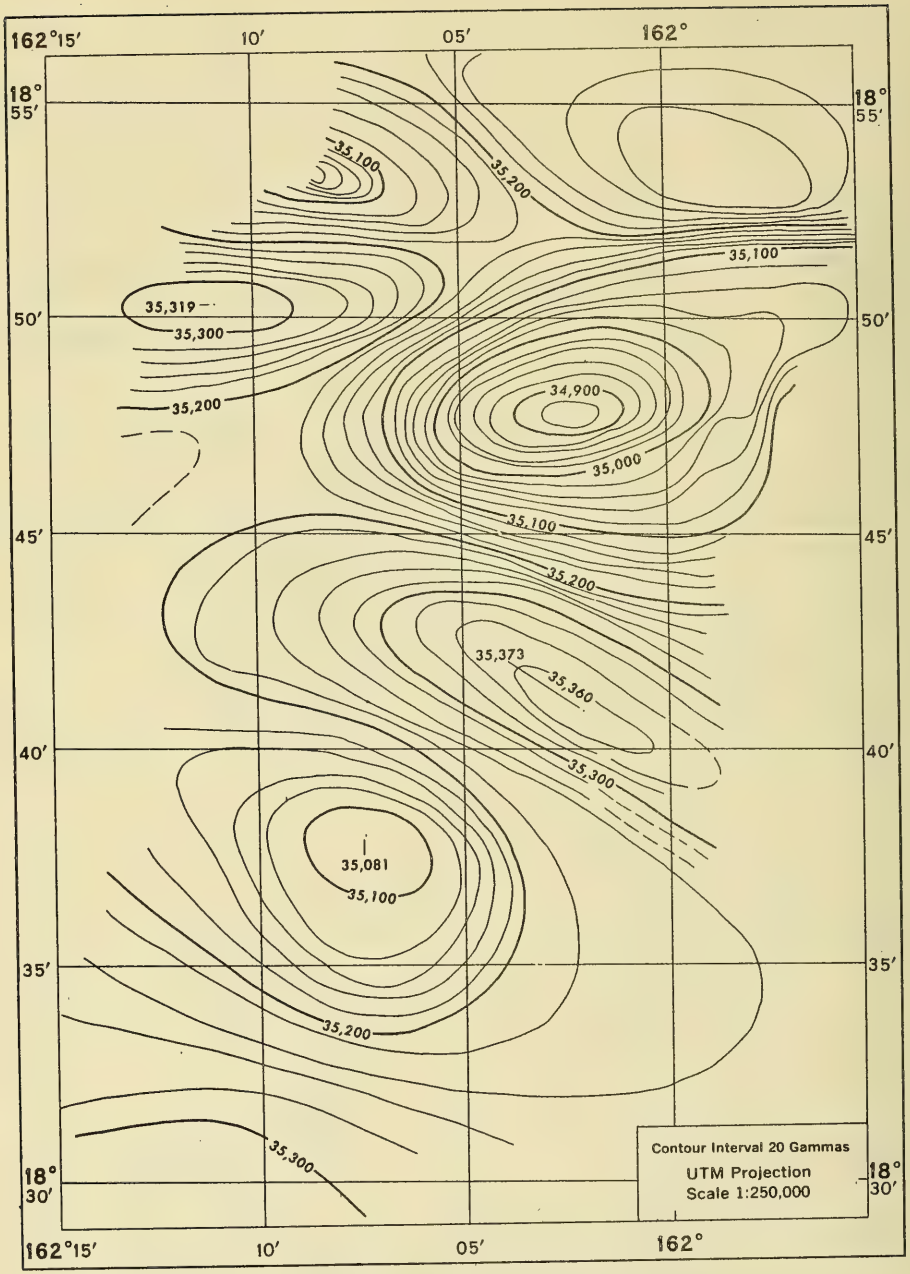


FIGURE 18 DEVELOPMENT AREA 2 MAGNETIC TOTAL INTENSITY CONTOUR CHART

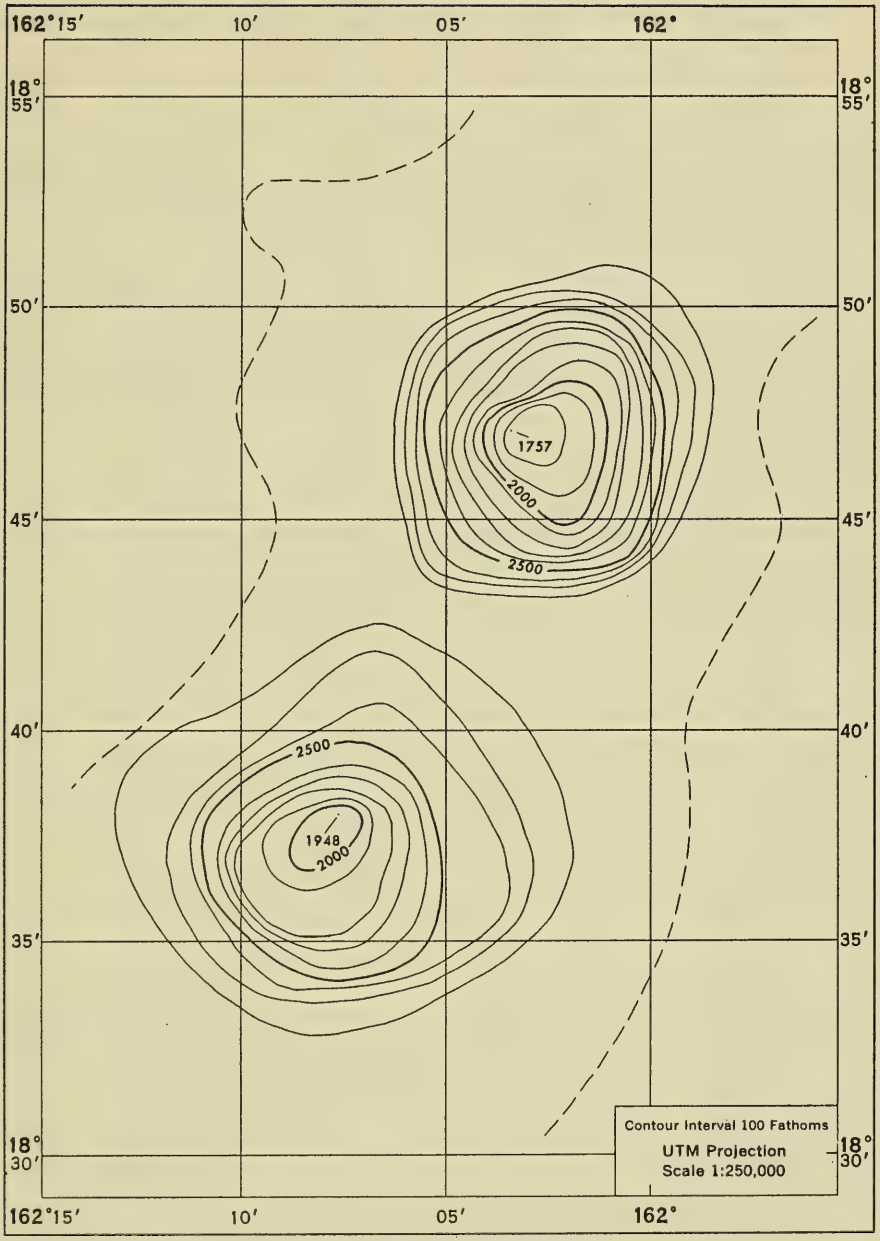


FIGURE 19 DEVELOPMENT AREA 2 BATHYMETRIC CONTOUR CHART

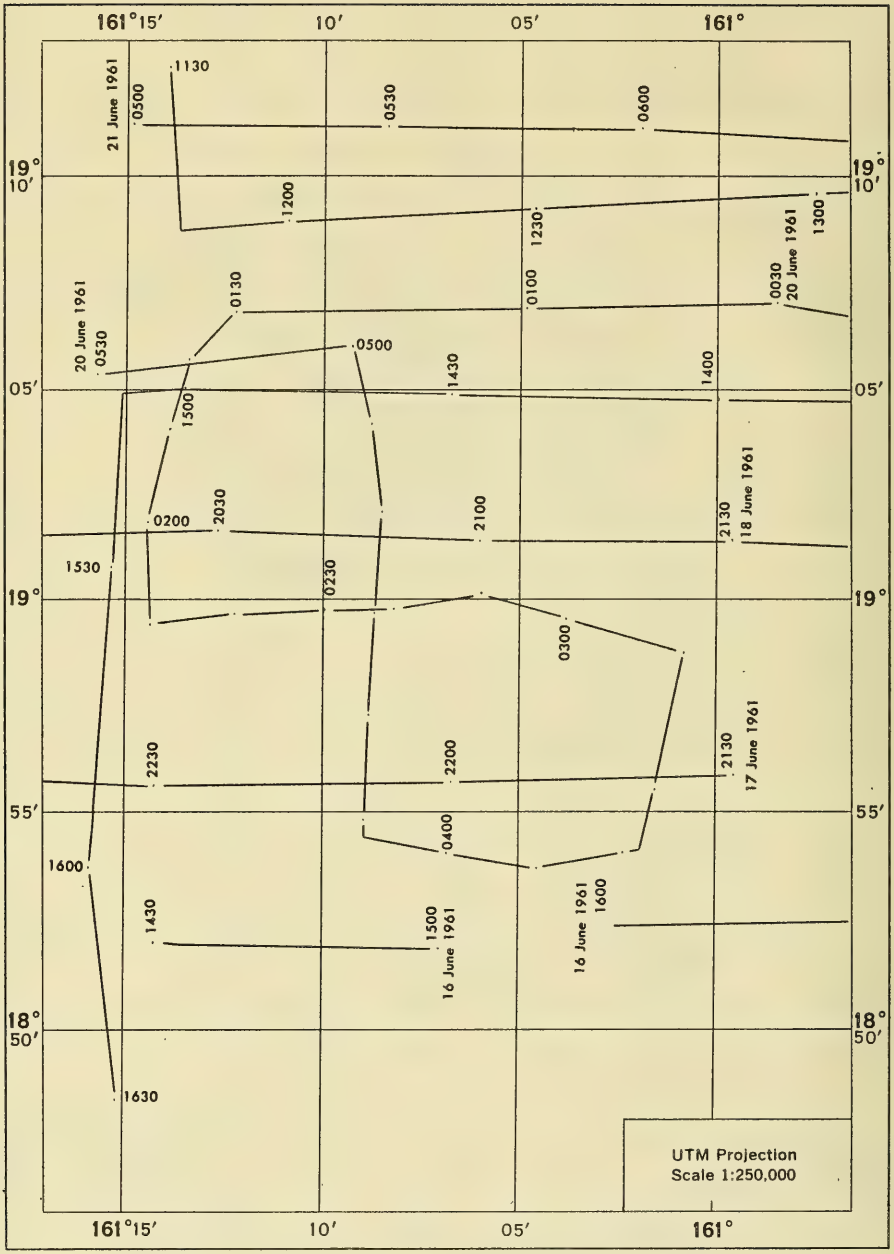


FIGURE 20 DEVELOPMENT AREA 3 TRACK CHART

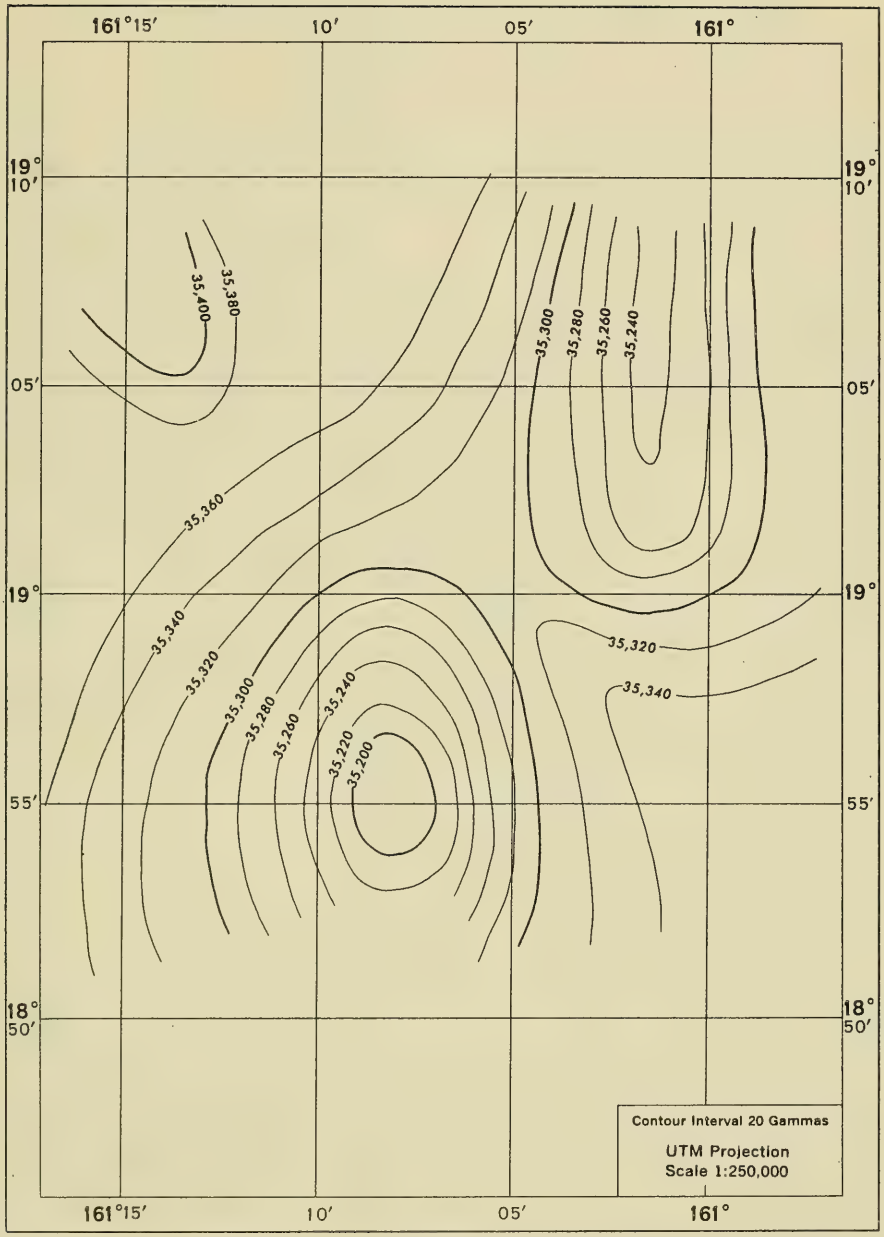


FIGURE 21 DEVELOPMENT AREA 3 MAGNETIC TOTAL INTENSITY CONTOUR CHART

FIGURE 22 DEVELOPMENT AREA 3 BATHYMETRIC CONTOUR CHART

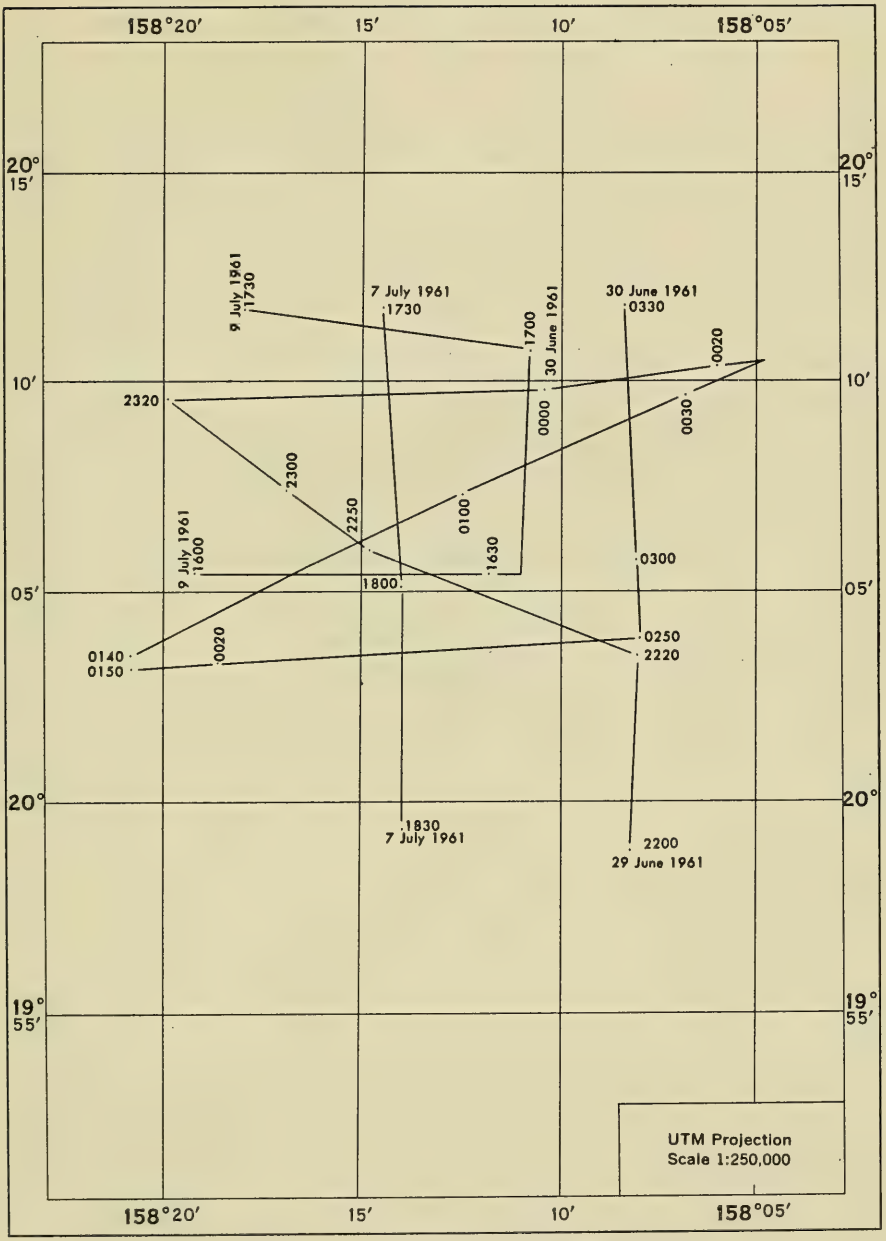


FIGURE 23 DEVELOPMENT AREA 4 TRACK CHART

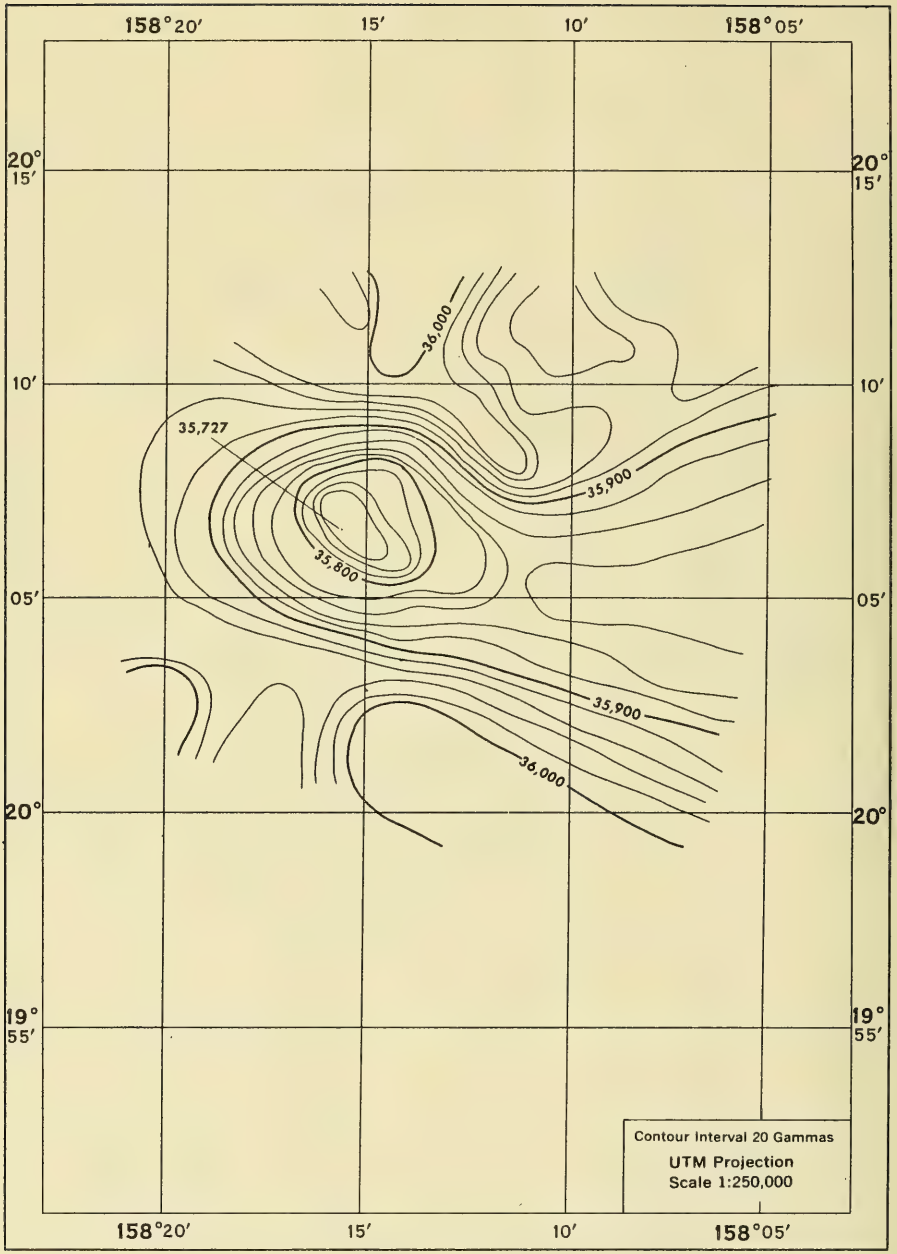


FIGURE 24 DEVELOPMENT AREA 4 MAGNETIC TOTAL INTENSITY CONTOUR CHART

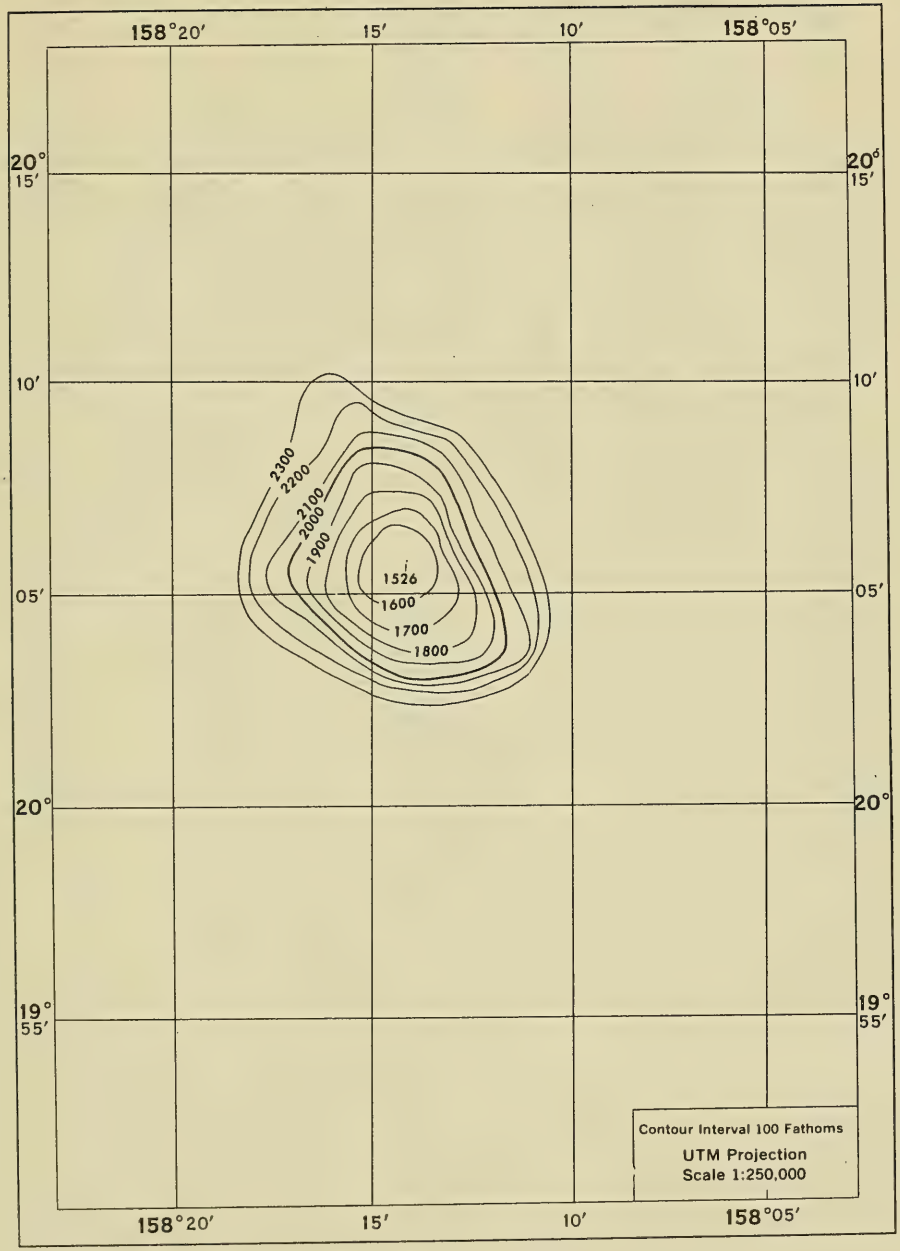


FIGURE 25 DEVELOPMENT AREA 4 BATHYMETRIC CONTOUR CHART

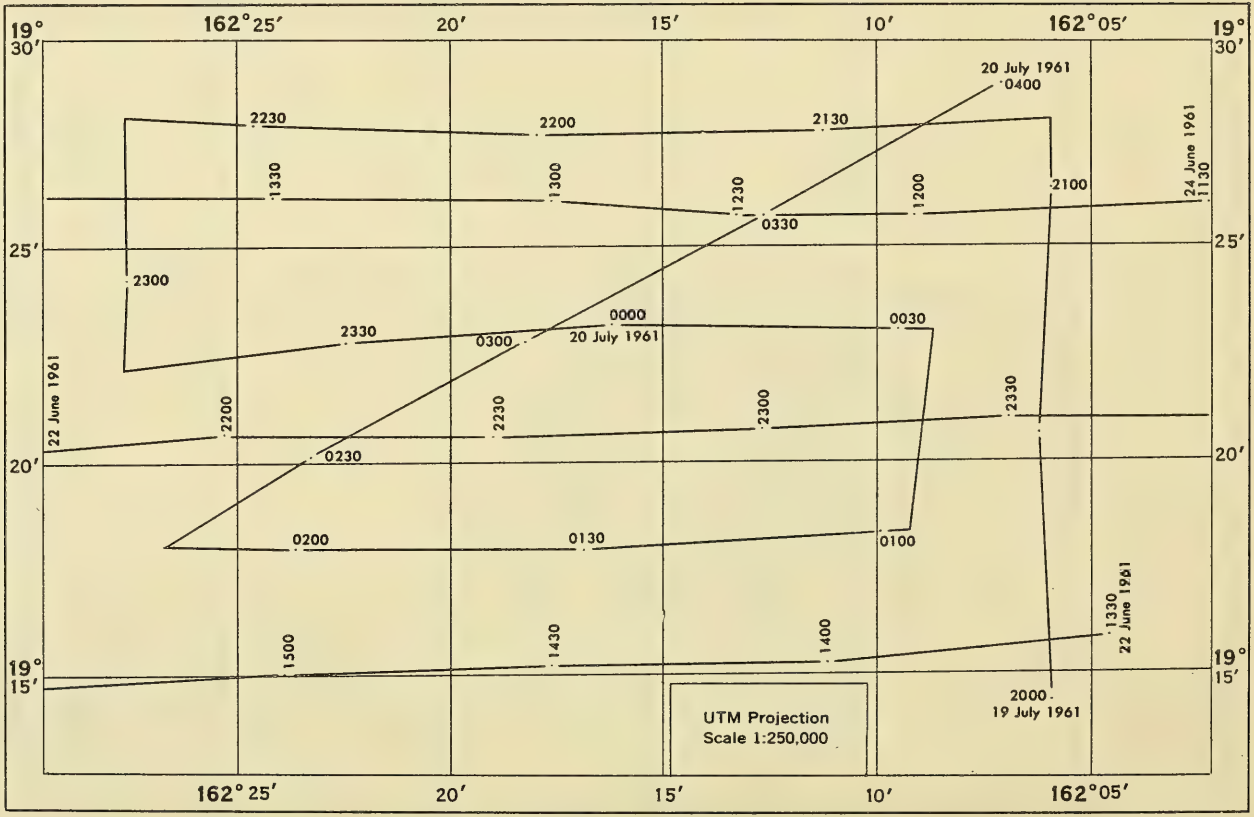


FIGURE 26 DEVELOPMENT AREA 5 TRACK CHART

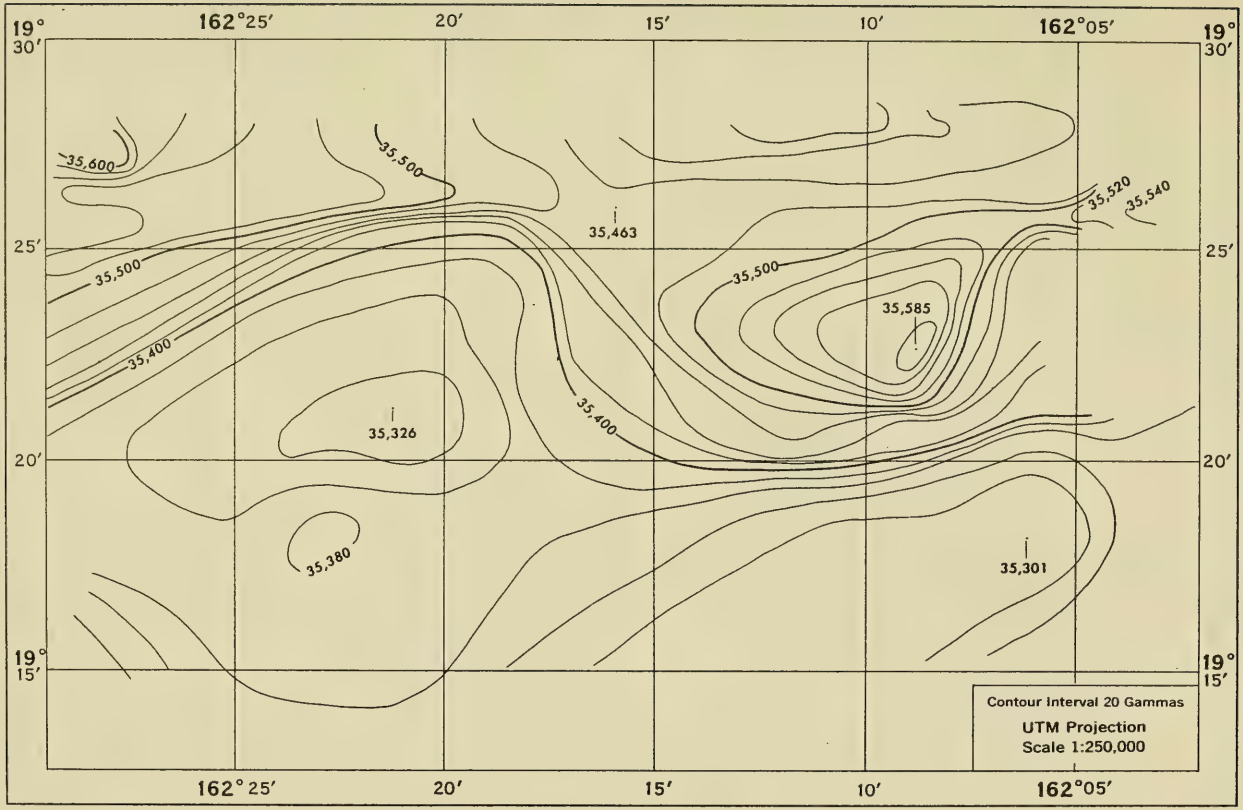


FIGURE 27 DEVELOPMENT AREA 5 MAGNETIC TOTAL INTENSITY CONTOUR CHART

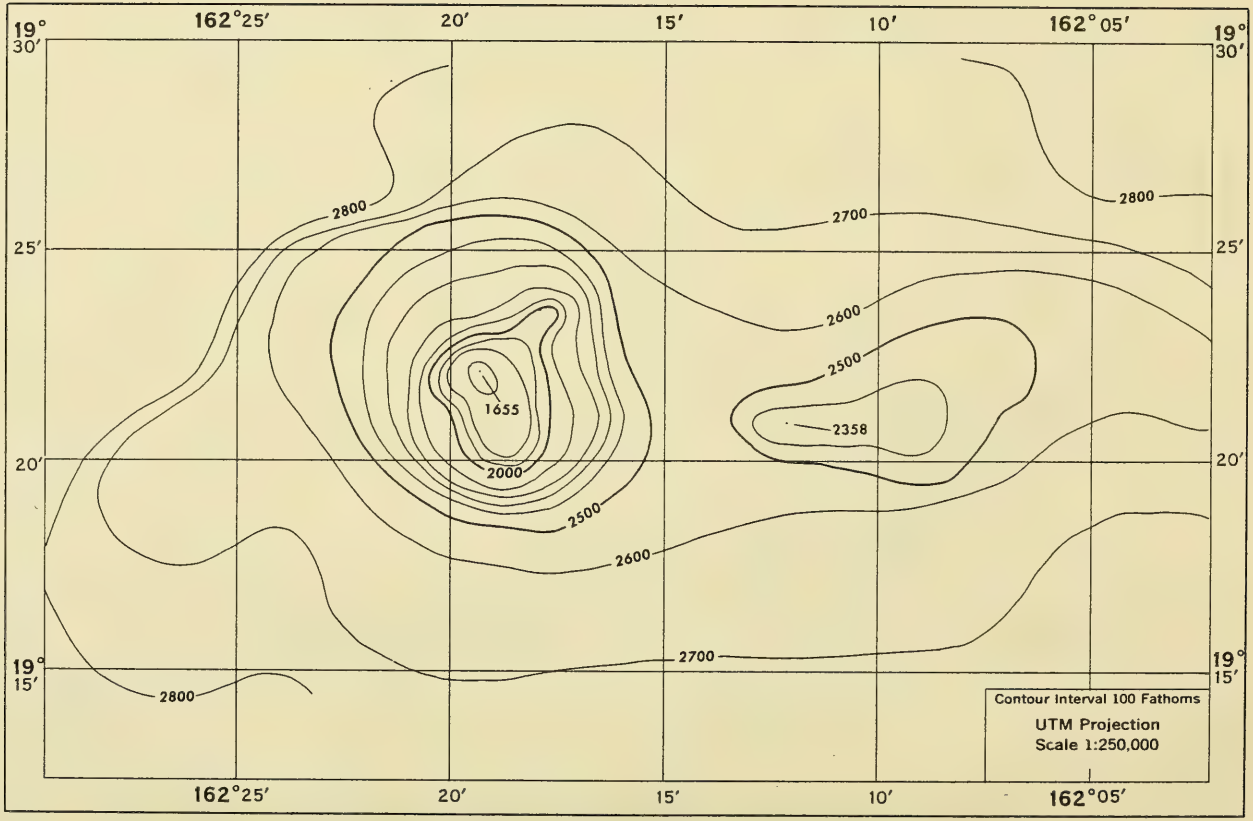


FIGURE 28 DEVELOPMENT AREA 5 BATHYMETRIC CONTOUR CHART

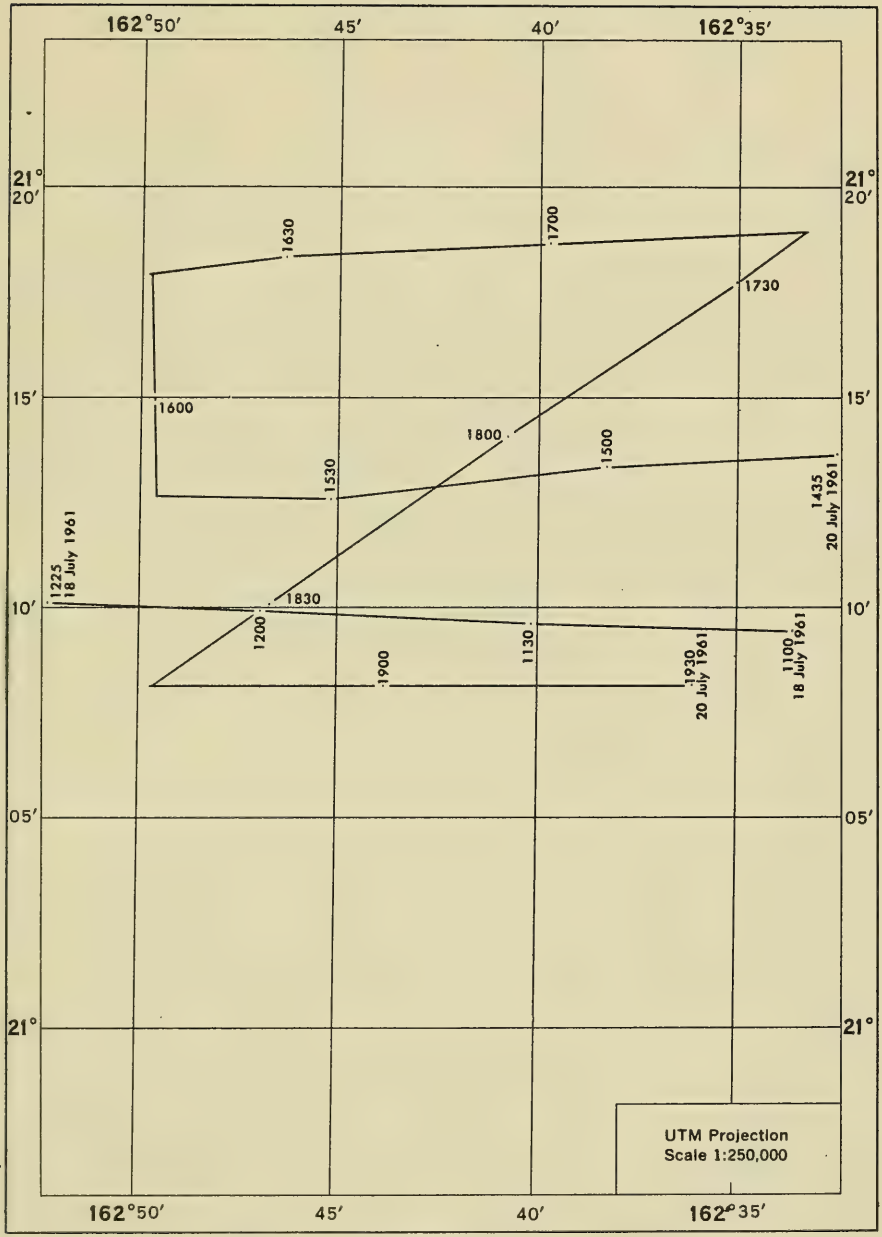


FIGURE 29 DEVELOPMENT AREA 6 TRACK CHART

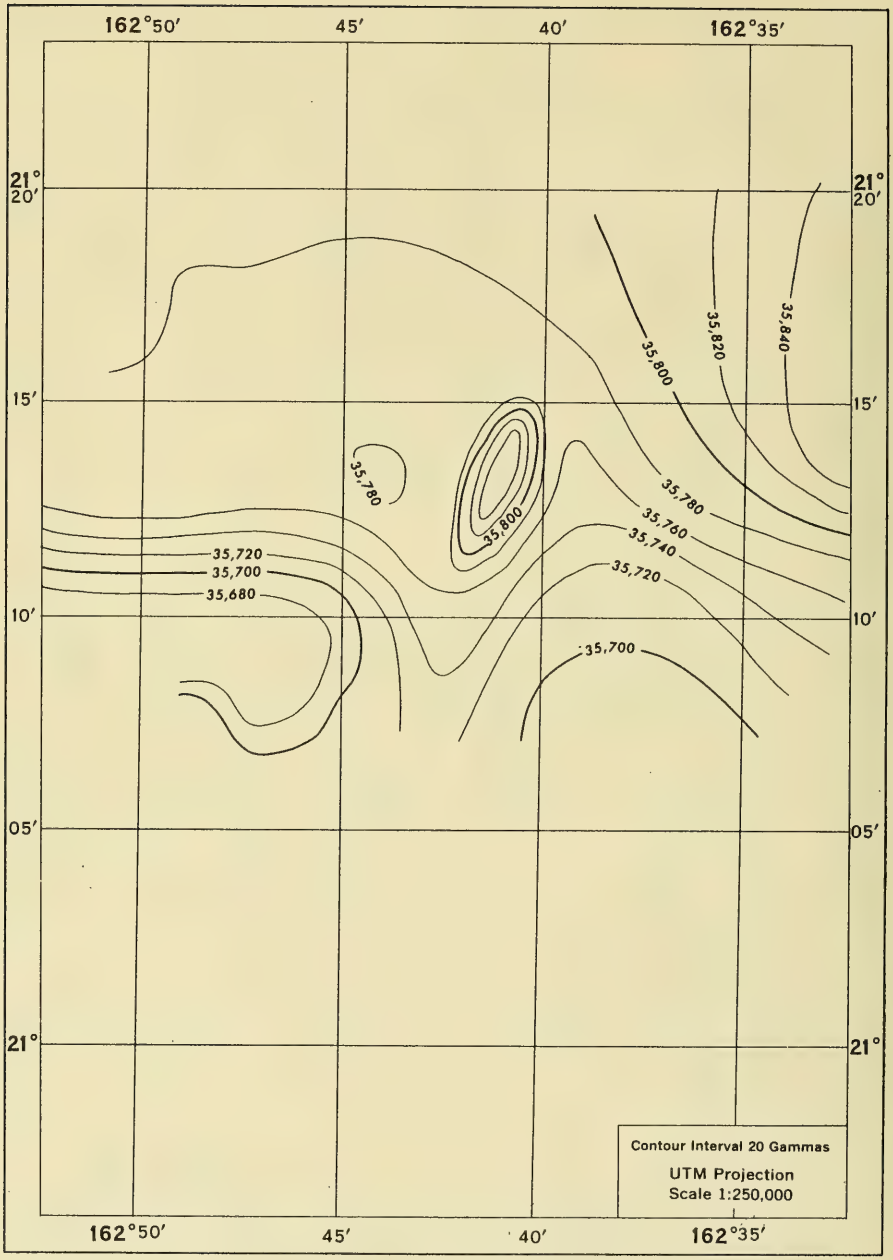


FIGURE 30 DEVELOPMENT AREA 6 MAGNETIC TOTAL INTENSITY CONTOUR CHART

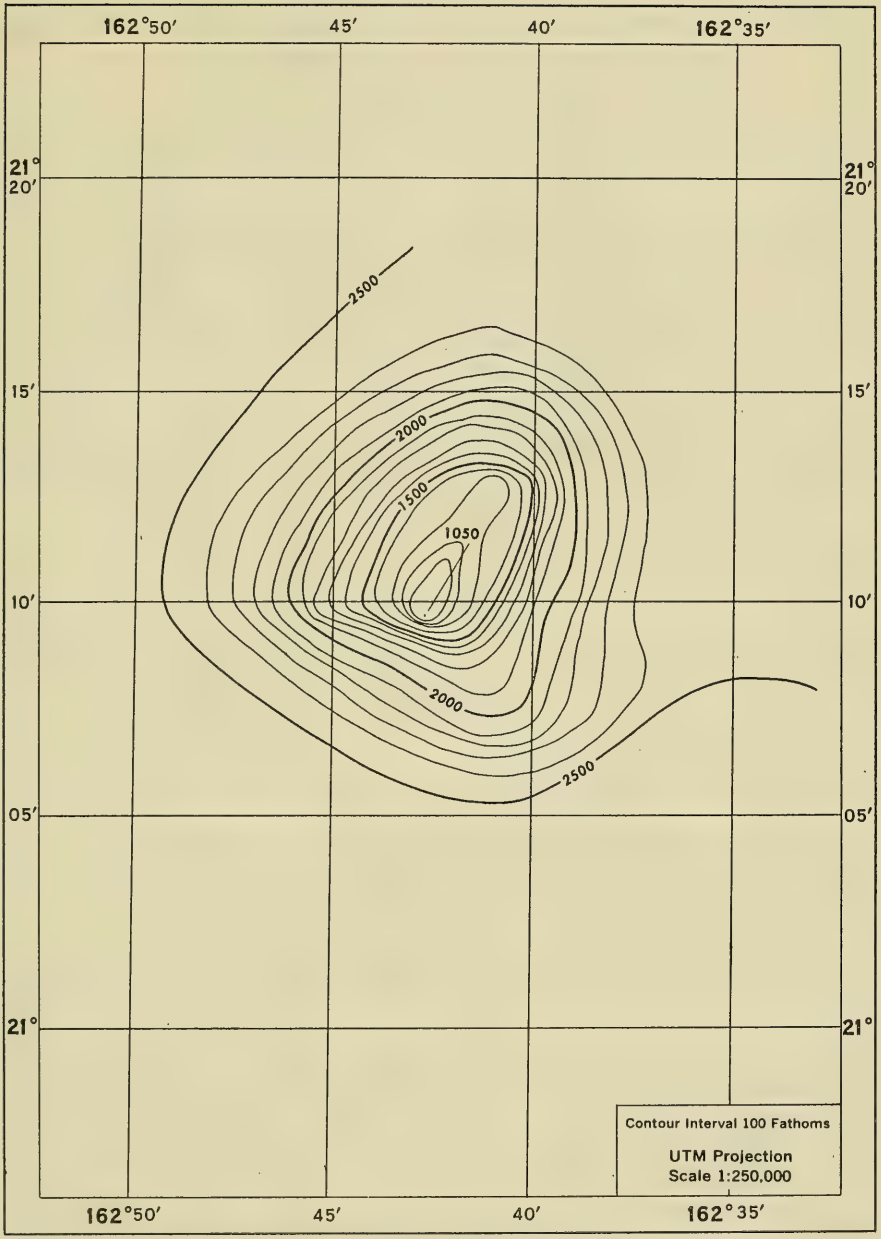


FIGURE 31 DEVELOPMENT AREA 6 BATHYMETRIC CONTOUR CHART

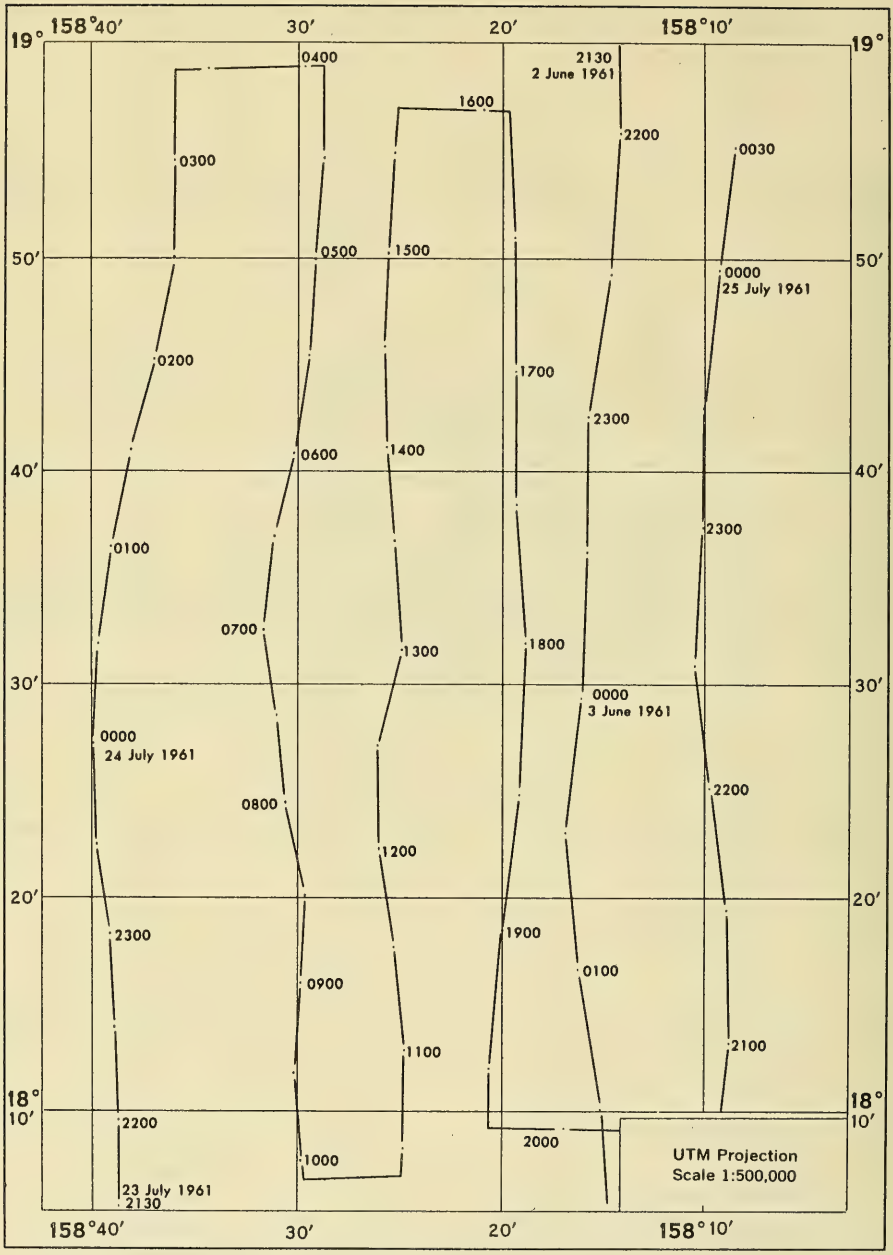


FIGURE 32 DEVELOPMENT AREA 7 TRACK CHART

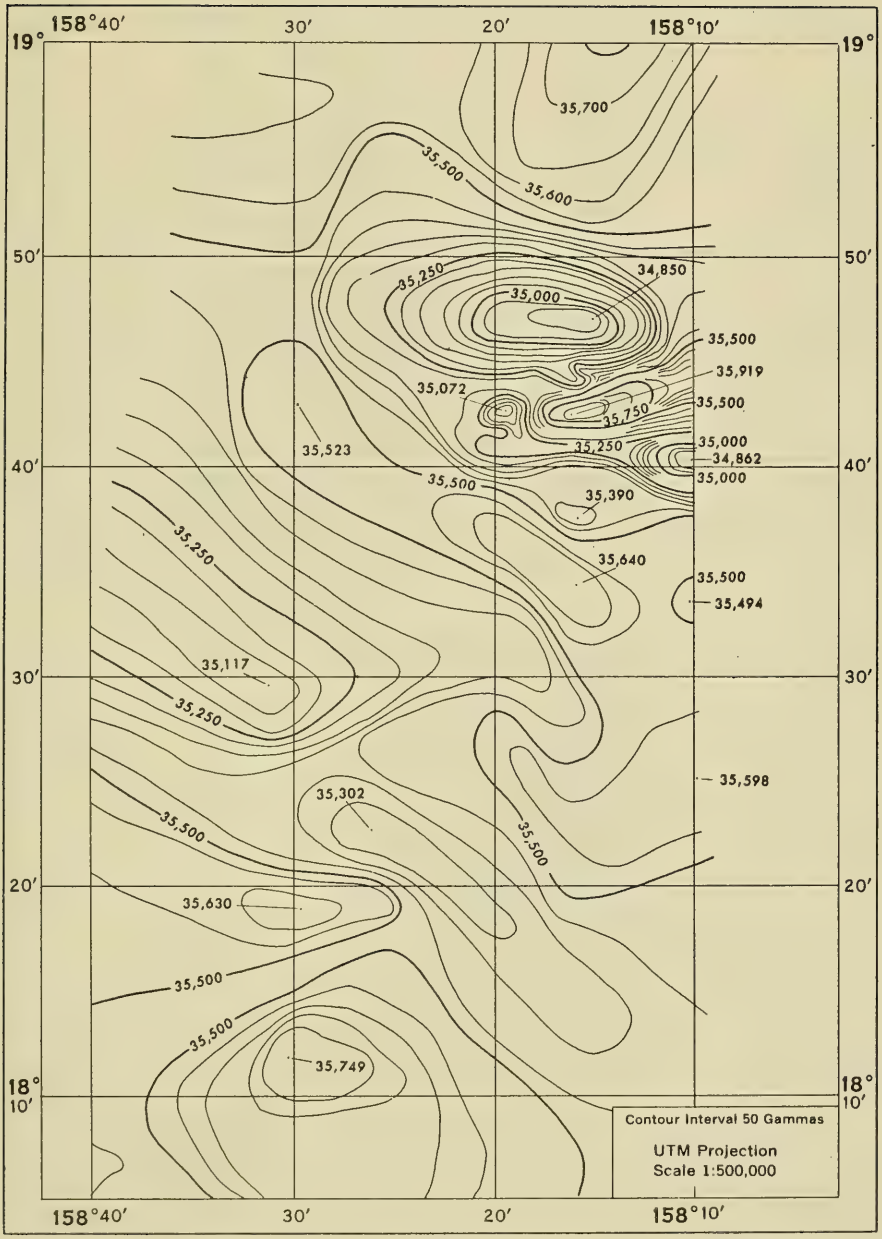


FIGURE 33 DEVELOPMENT AREA 7 MAGNETIC TOTAL INTENSITY CONTOUR CHART

FIGURE 34 DEVELOPMENT AREA 7 BATHYMETRIC CONTOUR CHART

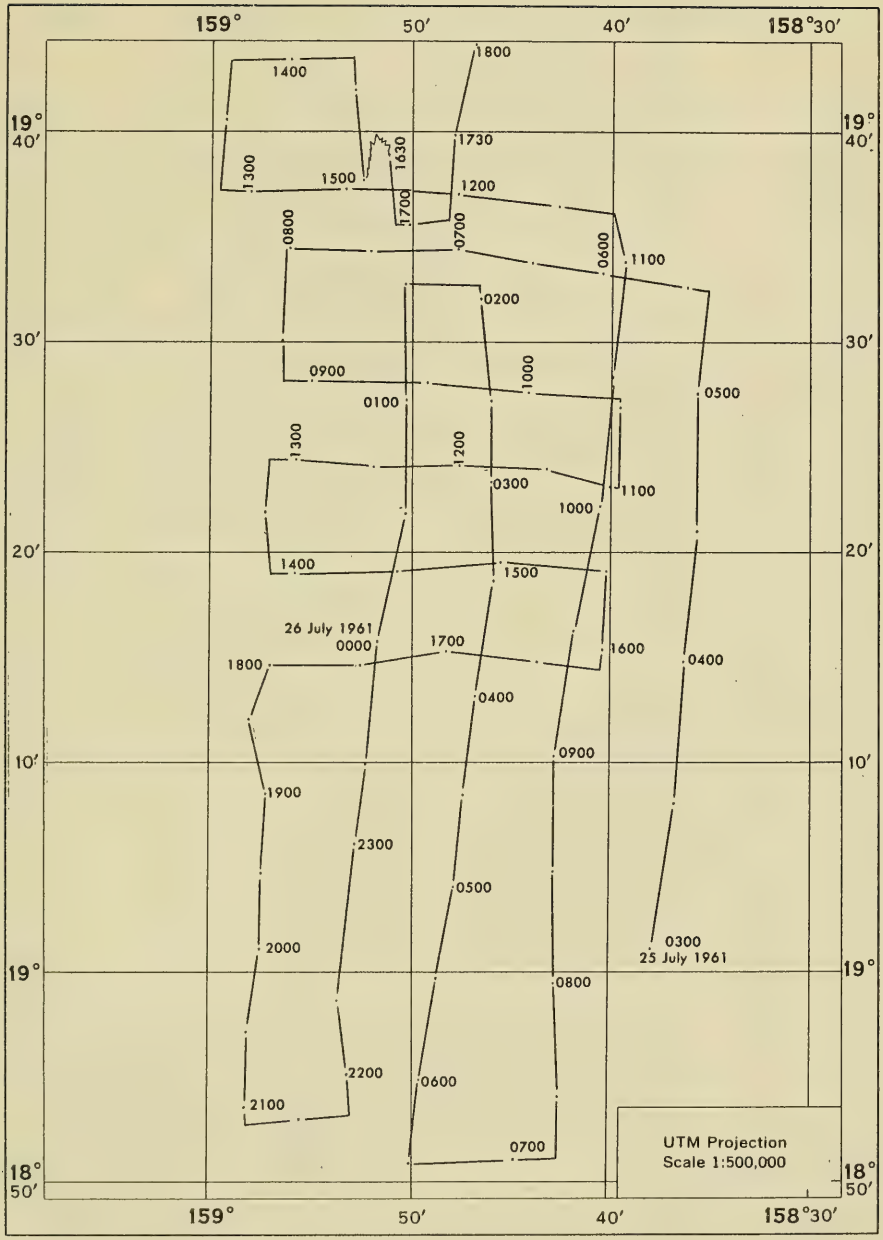


FIGURE 35 DEVELOPMENT AREA 8 TRACK CHART

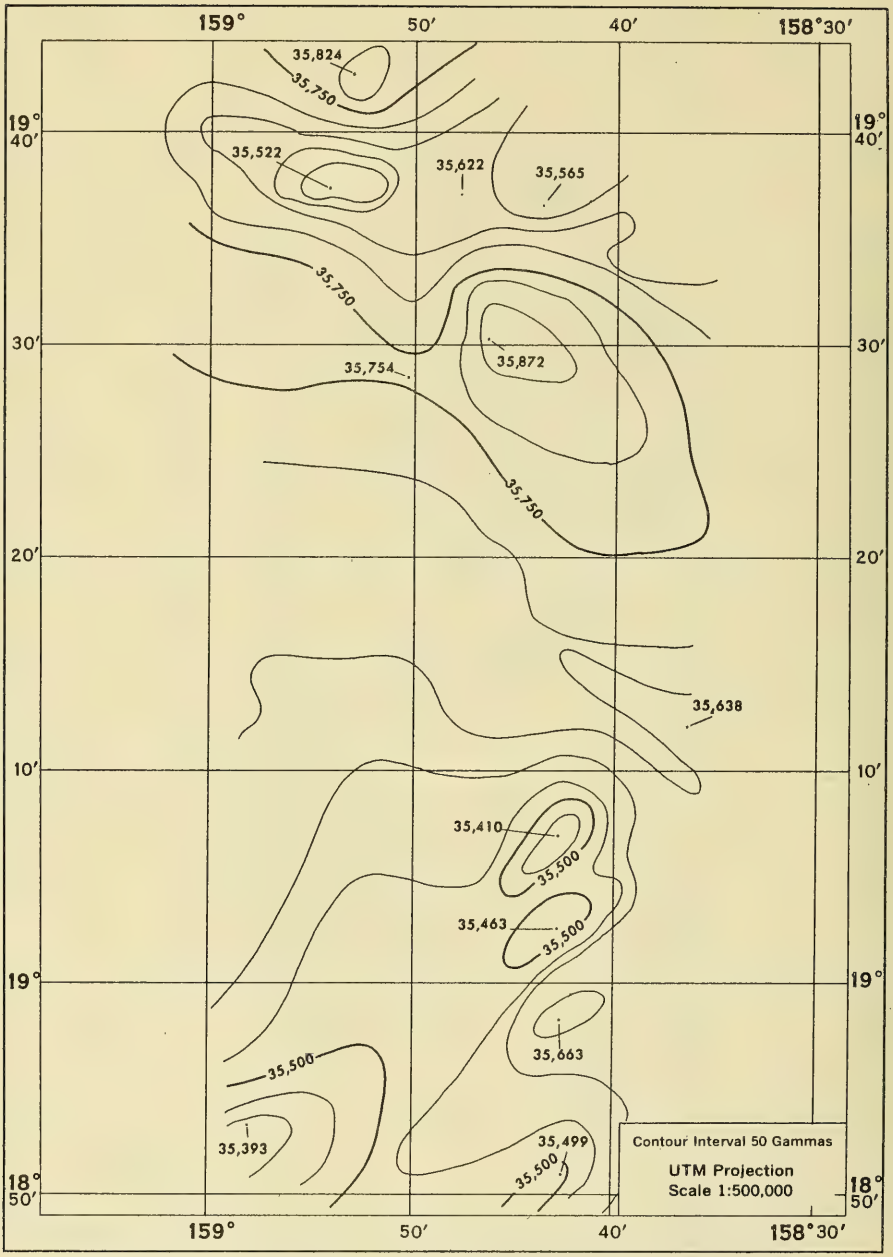


FIGURE 36 DEVELOPMENT AREA 8 MAGNETIC TOTAL INTENSITY CONTOUR CHART

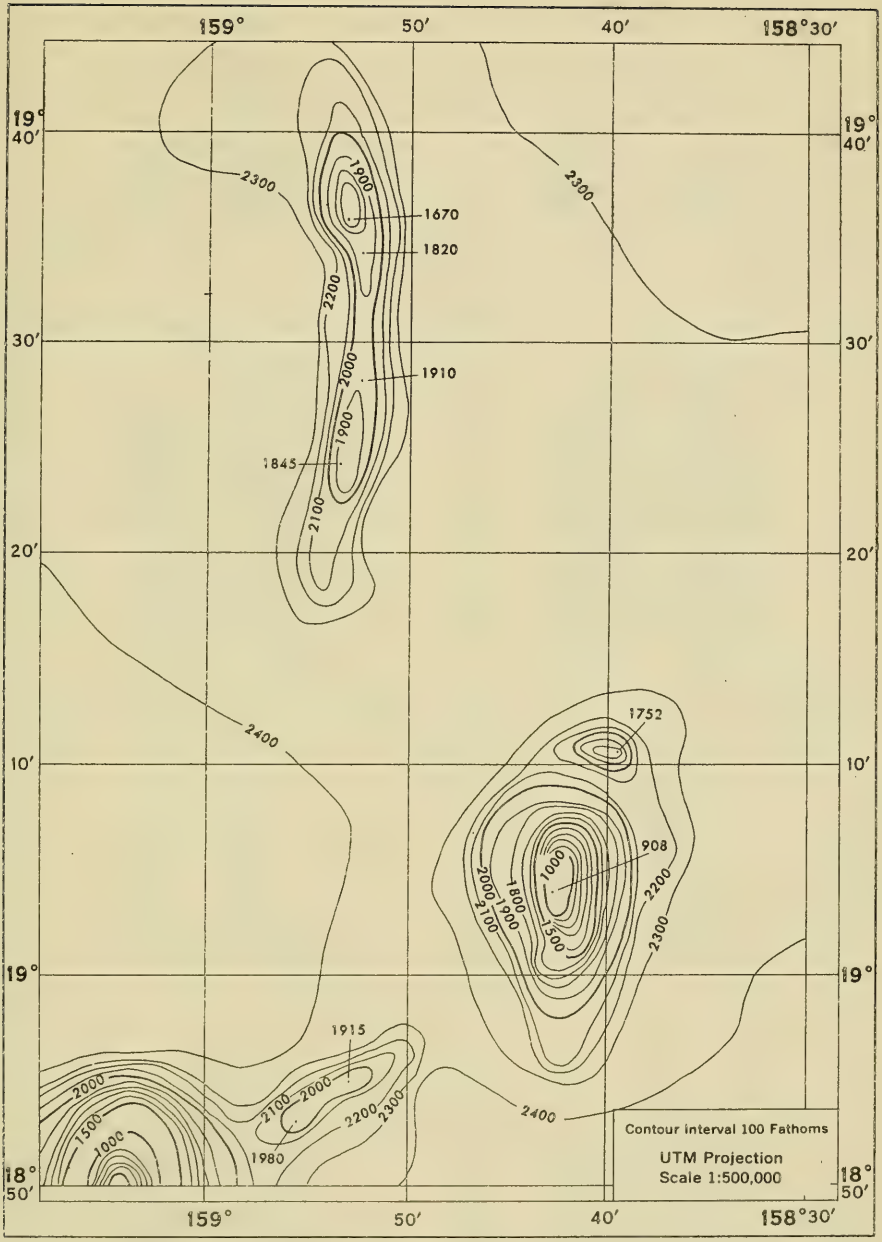


FIGURE 37 DEVELOPMENT AREA 8 BATHYMETRIC CONTOUR CHART

U. S. Naval Oceanographic Office
A MARINE MAGNETIC SURVEY
SOUTH OF THE HAWAIIAN ISLANDS,
September, 1962. 47 p., including
37 figs. (TR-137)

Detailed marine magnetic surveys were conducted in a 56,000 square mile area south of the Hawaiian Islands. The data reveal magnetic lineations which suggest that a major fault zone occurs in this region.

1. Magnetism, Terrestrial--Pacific Ocean
2. Pacific Ocean - Magnetism

i. Title: <u>A Marine Magnetic Survey South of the Hawaiian Islands</u>

ii. TR-137

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